Burgdorfer, Willy 1986

Dr. Willy Burgdorfer Oral History 1986

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Deirdre	Boggs
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I interviewed Dr. Willy Burgdorfer on tape in three different sessions, beginning on July 10, 2001, and ending in August. After reading the transcribed version of the interviews, Dr. Burgdorfer wished to make some changes and refinements to the answers that he gave to the interview questions. He finished making the desired changes at the beginning of October 2001. The following transcription reflects Dr. Burgdorfer's oral responses to the interview questions as later edited and supplemented by Dr. Burgdorfer.

This is Deirdre Boggs of Historical Research Associates interviewing Dr. Willy Burgdorfer in Hamilton, Montana on July 10, 2001. The interview is being done at the request of the National Institutes of Health.

DB: Dr. Burgdorfer, I'd like to begin by asking you where you grew up and what your first language was?

WB: I was born and grew up in Basel, Switzerland. Basel is in the northwest corner of the country where German is spoken, so my mother tongue is German.

DB: Where and how did you learn to speak English?

WB: I became exposed to the English language for four years in gymnasium.

DB: Can you still speak German?

WB: Oh, yes.

DB: And do you ever speak German anymore?

WB: Yes, I do. Some of my correspondence is still written in German.

DB: Although you've been speaking English for many years. Isn't that true?

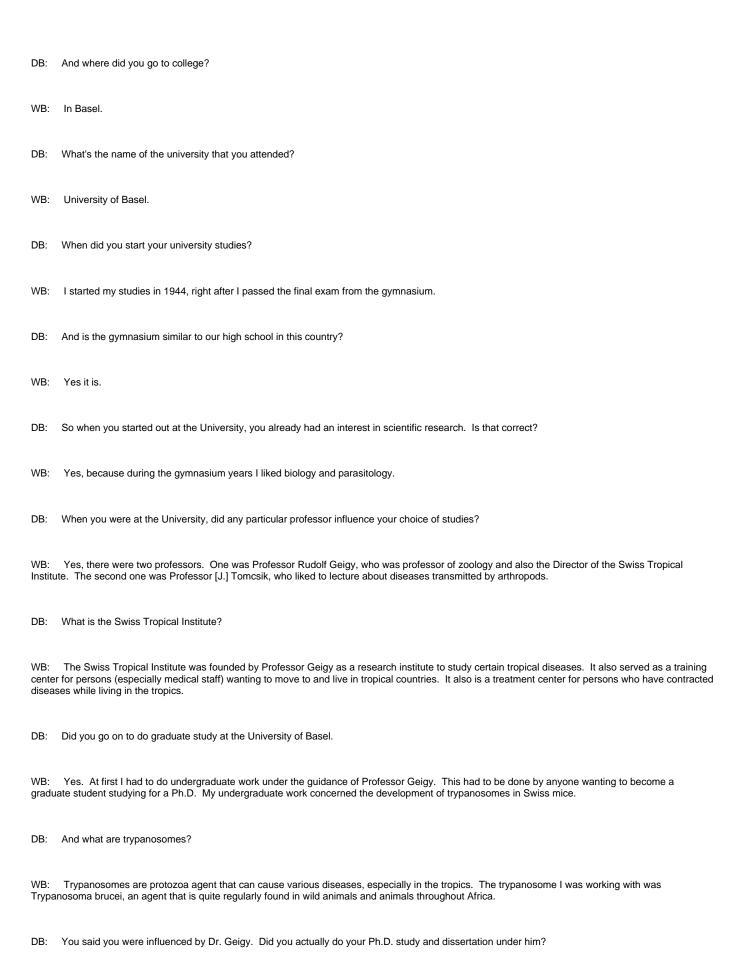
WB: Yes.

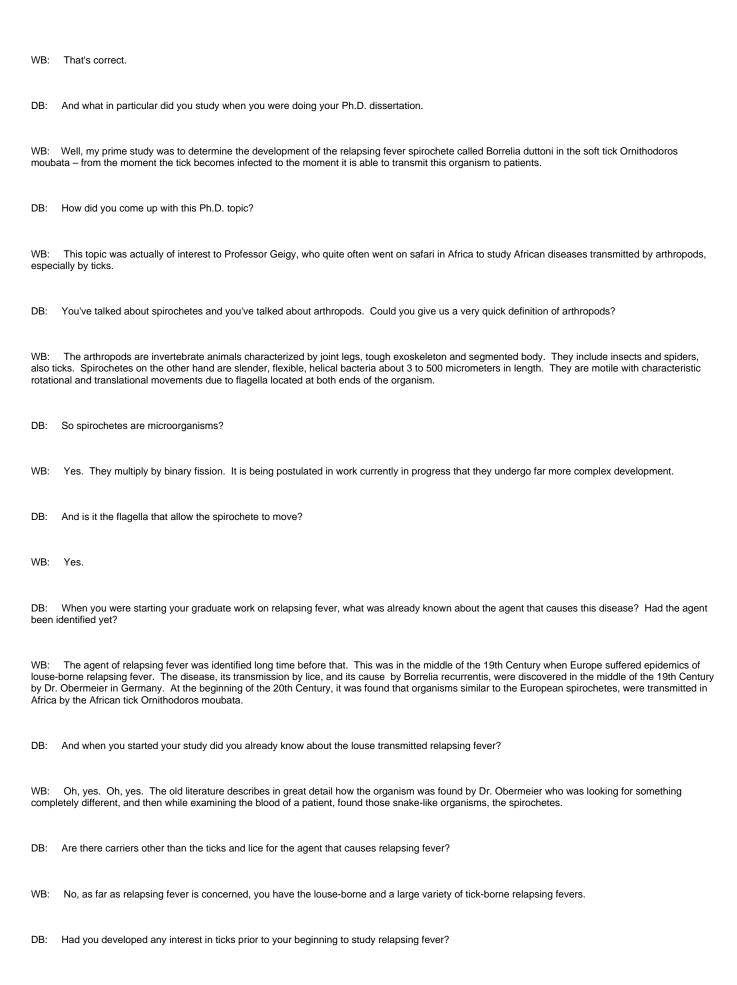
DB: For over 50 years?

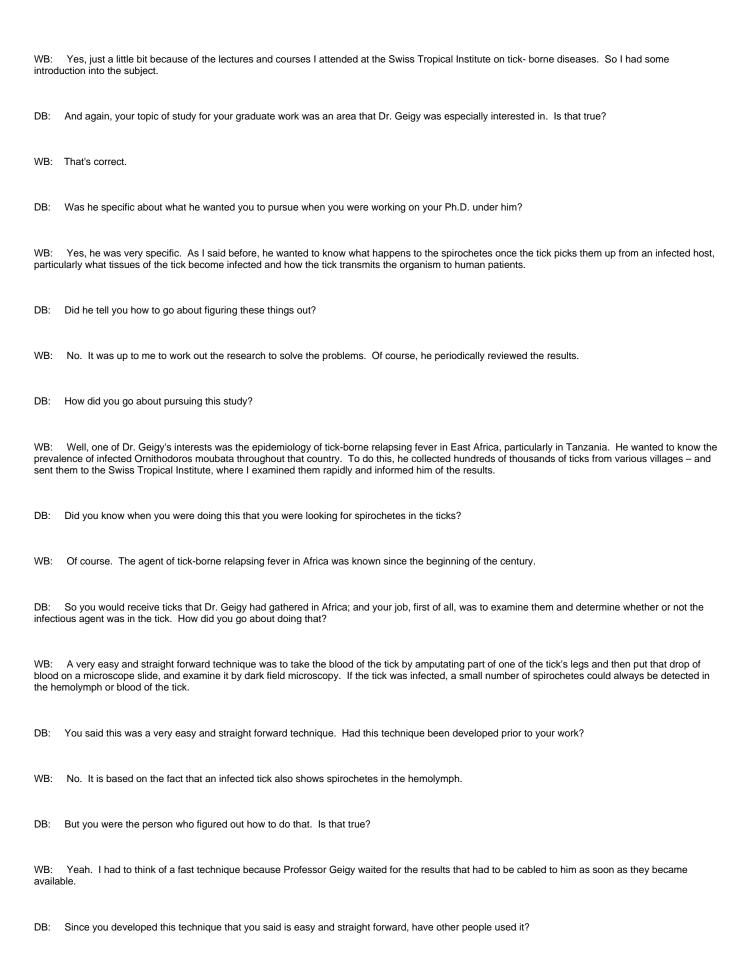
WB: That's true.

DB: Did your parents encourage you to attend university?

WB: Yes, both my mother and father did. Mother wanted me to become a teacher, but Dad suggested I become a research scientist to eventually seek a position in one of Basel's pharmaceutical companies such as CIBA, Sandoz, Hoffman La Roche, Geigy and others. I followed Dad's advice and included in my curriculum at the university zoology, bacteriology, entomology, parasitology and hygiene.





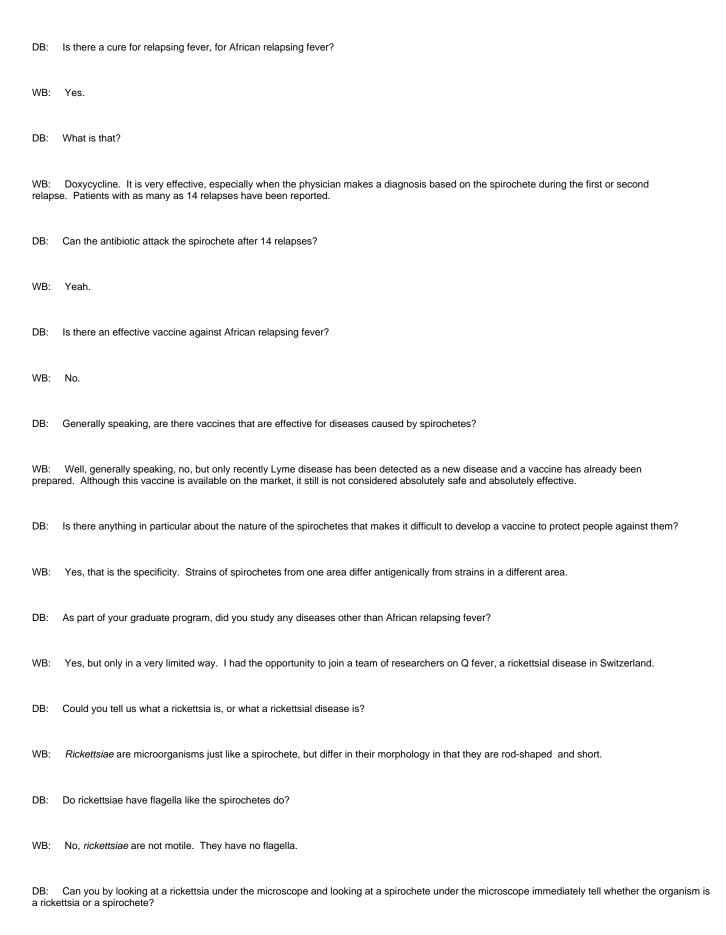


WB: Oh, yes, because this procedure was based on the fact that tick-borne agents usually infect the ticks' blood cells. Once spirochetes are detected in the hemolymph (blood cells), one can safely assume that the tick is infected.
DB: Before you began your Ph.D. studies and before you began specifically examining these ticks to see if there were spirochetes in them, had you performed surgery on ticks?
WB: No, no.
DB: That was the technique you had to learn?
WB: That was part of my thesis to determine in what tissues the organism is located and the first thing, of course, I had to do is to familiarize myself with the anatomy and the histology of the tick. So I became a "tick surgeon" during my Ph.D. years.
DB: Not to jump ahead too much, but have you continued during your lifetime to be a tick surgeon?
WB: I guess I have.
DB: Do you have any idea at all of how many ticks you've dissected?
WB: Thousands and thousands and thousands and thousands. No, I have not. To study the distribution and development of pathogens in ticks, I had to examine each tissue very carefully under the microscope.
DB: Just on your own speculation, do you think there's anyone else in the world who has dissected as many ticks as you have?
WB: That's very difficult to say. There are now many schools medical entomology departments – and even state health departments, where tick dissection is part of a program to familiarize students with the anatomy of ticks for the purpose of studying the development of a certain microorganism maintained and distributed by ticks.
DB: Have you yourself instructed people how to do this, how to dissect ticks?
WB: Yes, that was part of my teaching. I have taught entomology courses where part of the program was the dissection of ticks and the staining of the tissues for certain pathogens.
DB: The time that you were working on your dissertation, were spirochetes known to cause other diseases besides relapsing fever?
WB: Yes, <i>leptospirae</i> were known to cause leptospirosis in animals and humans; and in South Africa, the spirochete <i>Borrelia theileri</i> was said to cause mild affliction in cattle, and this spirochete was known to be transmitted by several species of ixodid ticks. Finally there is <i>Treponema pallidum</i> , the spirochete that causes syphilis.
DB: During the course of your Ph.D. studies, did you learn how a tick does transmit the agent that causes relapsing fever?
WB: That was one of the main objectives of the thesis, to do a dynamic study and follow the organism from the moment the tick picks it up to the moment it transmits it. And, of course, you had to study the development of the spirochete in the salivary gland tissues because the transmission occurs via saliva of the tick, and that was an important part of the thesis.

DB:	And you were the person who discovered that it was transmitted through the saliva of the tick?
WB: Ugand	No, no, I was not the first one. That had been done by scientists like Dr. Robert Koch, and by British scientists at the turn of the 20th Century in da and Kenya. They were the first to find that spirochetes are not only transmitted by lice but also by ticks.
DB:	Did you learn how the spirochete travels to different parts of the victim's body once it enters the body?
WB:	You mean the patient?
DB:	Yes, the patient.
WB: acces	No, that was not my job. As a medical entomologist, I was interested but I was not an expert in clinical manifestations of the disease. I had no s to patients and only limited access to animals, such as monkeys, guinea pigs and/or rodents.
DB:	Tell me what tools you used in order to pursue your studies? Again, when you were working on your Ph.D. thesis. I assume you had a microscope.
be rer	Yes, I had a microscope, and a collection of very fine eye-scalpels and Swiss watchmaker forceps. Eye scalpels were used to open the ticks by g along the lateral margin. Once the dorsal exoskeleton was removed, the entire internal structure the organs of the tick – became visible and could noved by means of the fine forceps. Because scalpels and forceps are not always available in the tropics, Dr. Geigy taught us to perform dissections sect needles – a job that works well on soft-shelled ticks like Ornithodoros moubata, but is very difficult for opening hard-shelled ticks.
DB:	And have you done it with a needle?
WB:	Oh yes.
DB:	Have the tools that you used to dissect a tick changed over the 50 some years that you've been doing that?
WB:	No, they're still the same. It's still up to you to train yourself to dissect a tick with any instrument.
DB:	And there's a good microscope, of course.
WB:	And of course a good microscope, yes.
DB: Africa	Dr. Burgdorfer, at what stage in the tick's development is it expected to bite a human being, and again we're talking about the tick that transmits n relapsing fever?
WB:	Very likely in the nymphal and adult stages, since the larval stage does not feed.
DB:	At what stage does the tick become infected?
WB: addition	Because the larval stage of Ornithodoros moubata is not parasitic, this tick becomes infected as a nymph by feeding on a spirochetemic host. An onal mode for Ornithodoros moubata to acquire spirochetes is by transovarial transmission—which is the passage of spirochetes from an infected e tick via eggs to her progeny.

DB:	If the tick becomes infected from an infected victim, what species of victim does it usually pick up the spirochete from?
WB: only re	We still don't know the natural source for these ticks to become infected, although it is commonly assumed that humans are the only source, the eservoir for the infection of the tick.
DB: victim.	So what you're saying is the tick picks up the spirochete from a human and then bites an uninfected human and passes the spirochete to this new
WB:	Right.
DB:	And how does the victim come in contact with the tick that causes African relapsing fever?
WB: were a	Through a person's exposure to tick-infested soil in poorly constructed quarters. Natives, for instance, slept on bare ground floors from where they attacked during the night by ticks hiding in the soil.
DB:	When you were working on your dissertation in the 1940's, were ticks known to cause other diseases than African relapsing fever?
WB:	Oh yes.
DB:	What were those diseases?
fever" Taylor	The first evidence that ticks are involved as vectors of pathogens dates back to the middle of the 19th Century when it was found that "Texas Cattle was caused by the protozoan agent Babesia bigemina, transmitted by the cattle tick Boophilus microplus. At about the same time, Dr. Howard Ricketts reported that the Rocky Mountain wood tick, Dermacentor andersoni, transmits an agent (later established as a rickettsia) causing Rocky ain spotted fever. Other tick-borne diseases include Colorado tick fever and Russian spring summer encephalitis.
DB:	Was Russian spring summer encephalitis known about in the 1940's?
WB:	Yes.
DB:	Do you know if any animals other than humans get African relapsing fever when they're exposed to the spirochete that causes it in human beings?
WB: know v	That is a big question. We don't know the reservoir. We don't know what animals are susceptible to Borrelia duttoni as are humans. We don't whether there are animals that develop a spirochetemia like humans do.
DB: Africa.	Dr. Burgdorfer, when you were doing your Ph.D. studies, you said that your ticks were delivered to you by Dr. Geigy who gathered them in During your studies, did you do any field work to collect any other ticks yourself?
WB:	No.
DB:	Did Dr. Geigy talk to you at all about gathering ticks in the field?
WB:	Well, he told us the methods he used to search for ticks in the crevices and the sand of native huts inhabited by relapsing fever patients.

DB:	To the extent that you've gathered ticks yourself, you started to do that after you completed your Ph.D. studies?
WB:	Oh yeah. The only tick species I worked with during my Ph.D. studies was the African relapsing fever tick, Ornithodoros moubata.
DB:	Do all of those ticks, all of those African relapsing fever ticks, carry the spirochete that causes the disease?
WB: the hi	Not all. No, there's only a certain percentage in every given area. Professor Geigy wanted to know what villages, and where in such villages are ighest percentages of infected ticks.
DB:	So that is why it was important to him and to you to determine whether or not a tick population was infected.
WB:	That's right.
DB:	Do you know how relapsing fever is diagnosed?
	Yes. The best way to determine whether or not a sick patient has relapsing fever, is to examine his blood during the fever attacks. Relapsing fever ery characteristic disease, with multiple fever relapses during which the spirochetes circulate in the bloodstream. Therefore, microscopic examination satient's blood is the best means of diagnosis.
DB:	And have you done that yourself?
WB:	Oh yes.
DB:	Did you do that when you were preparing your Ph.D. studies?
WB: anima	Yes. The same thing with animals, experimental animals. You want to characterize a given strain of spirochetes, you inject white mice or other als and you follow daily the infection in the blood by examination of blood smears.
DB:	Had that technique been developed by the time that you started your studies?
WB: Ornith	Oh yes. That's how the British physicians at the turn of last century examined the patients and looked for spirochetes and determined that hodoros moubata is involved in the maintenance and transmission of this organism.
DB:	Is relapsing fever a health problem today?
	In some African countries you still have a small number of cases every year, but it is no longer the same problem as it had been in the past. Here United States, it's certainly no longer a problem. Little is known about Asian countries that occasionally report small outbreaks of the disease. We that they have louse-borne relapsing fever, but no longer to the same extent as in the last century.
DB:	Why is it that it's not the same problem that it used to be? Or do you know that?
WB: the di	I think improved living conditions. Natives in Africa no longer sleep on bare floors; they use carpets, or something like that, that protects them from irect exposure to ticks.

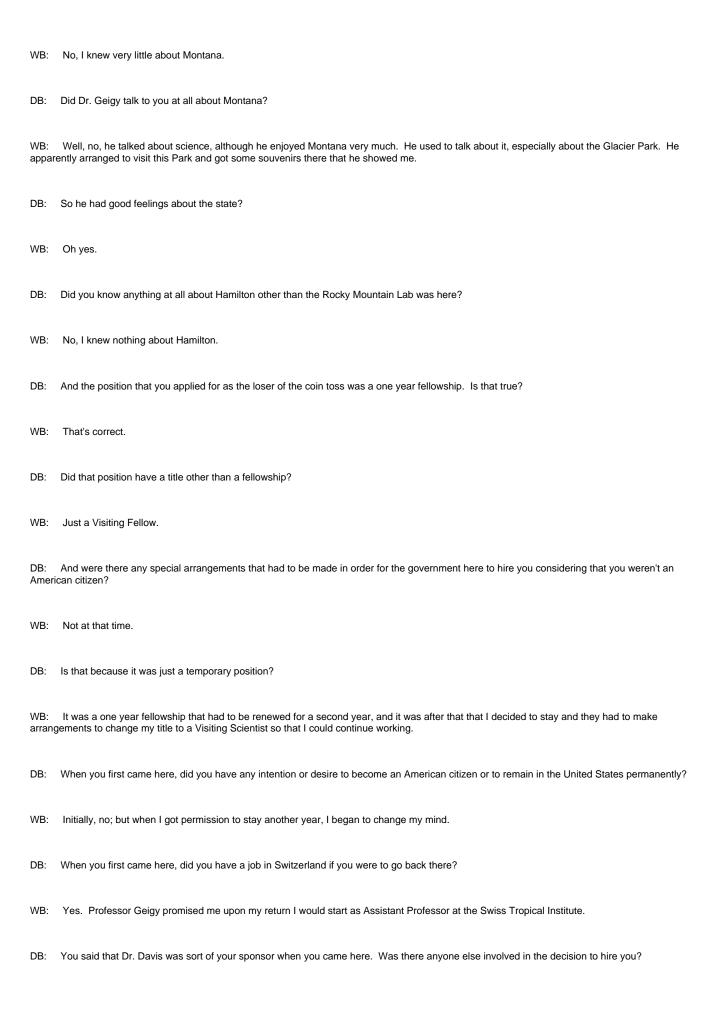


WB: rods.	Oh yes. As I said spirochetes have a very typical helical morphology, whereas <i>rickettsiae</i> are short, rods; sometimes they even look like spherical
DB:	So you had quite a bit of experience during your graduate studies identifying these two different organisms. Is that right?
	Well, as I said, on a limited basis. My job was to examine arthropods in the areas where Q fever cases did occur, and then to examine these pods as to whether they were infected with the Q fever agent, known as Coxiella burnetii. Q fever is in humans a respiratory illness and very, very uses are known where the tick was responsible for transmitting the organisms.
DB:	So, it's an airborne disease?
WB:	That's correct.
DB:	Can you tell us how the rickettsia that causes Q fever got its name?
WB:	How it got its name?
DB:	Yes.
	Yes I can. The Q stands for "query," meaning "questions." Q fever was first described in Australia as a disease of abattoirs (slaughterhouses). It ecognized as a rickettsial disease transmitted by ticks, although it was soon recognized as a disease resulting from inhalation of particulate eated rickettsial material.
DB:	What about the rickettsia itself, how is that named? Rather than the disease?
WB:	You mean Rickettsia rickettsii?
DB:	No, the Coxiella burnetii.
	Coxiella was named according to Dr. Cox, who was a scientist at Rocky Mountain Laboratory and who, together with Dr. Gordon E. Davis, ted ticks in the Nine Mile area, about 75 miles from here, and isolated an agent that was filterable and proved to be a new agent, for which the name iven honoring Dr. Cox's work on that subject.
DB: fever.	So you had heard of Dr. Cox and I take it you had heard of the Rocky Mountain Laboratory when you were a graduate student and studying Q Is that true?
WB:	Yes, studying Q fever, and also, of course, relapsing fever because Dr. Gordon E. Davis was the world's best known borreliologist.
DB:	Did Dr. Davis have any association with the Rocky Mountain Lab?
WB:	Dr. Davis?
DB:	Yes.

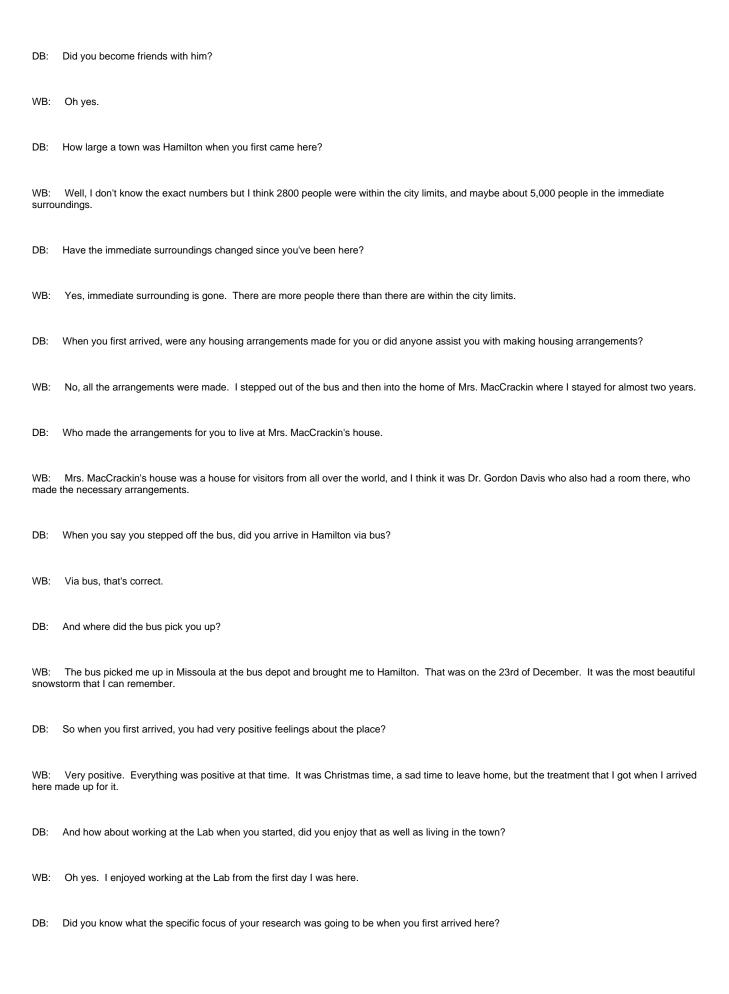
WB: tick-bo	Oh yes. During the World War he was working on yellow fever in Africa and after the War he started to work at the Rocky Mountain Laboratory or orne relapsing fevers.
DB:	Was Q fever a problem disease at the time that you were studying it in Switzerland?
	Yes, it was. Q fever epidemics did occur throughout the World War II years in Europe, and probably had to do with the movement of troops in ntrated areas. There were hundreds of cases, especially in Switzerland. It was thought that the disease was introduced from Australia in cattle, and goats.
DB:	When did you finish your Ph.D.?
WB:	I finished my Ph.D. in 1951.
DB:	Was your dissertation published?
WB:	Yes. It was published in the Acta Tropica.
DB:	Was it published in German?
WB:	It was published in German.
DB:	What was the title of your dissertation?
WB:	The title was
DB: that?	We're resuming the interview with you. I'm afraid we might not have picked up the whole title of your Ph.D. dissertation. Could you please tell me
WB: Englis	It's "Analyse des Infektionsverlaufes bei Ornithodorus moubata (Murray) und der naturlichen Uebertragung von Spirochaeta duttoni," which in h means the "Analysis of the Infection Process in Ornithodoros moubata (Murray) and the Natural Transmission of Spirochaeta duttoni."
DB:	Was it your goal after you completed your Ph.D. to stay in Switzerland?
WB: diseas	Yes, after I had first spent a one-year fellowship at the Rocky Mountain Laboratory under the guidance of Dr. Gordon E. Davis to study tick-borne ses.
DB:	And by that time, in addition to having your Ph.D. dissertation published, had you authored or co-authored any works that were published?
WB:	Yes, I had three publications by that time, two in German on relapsing fever, and one publication on Q fever research in Switzerland.
DB: fever?	And the Dr. Davis that you were going to work with at the Rocky Mountain Lab, was he the same Dr. Davis who had done pioneering work on Q

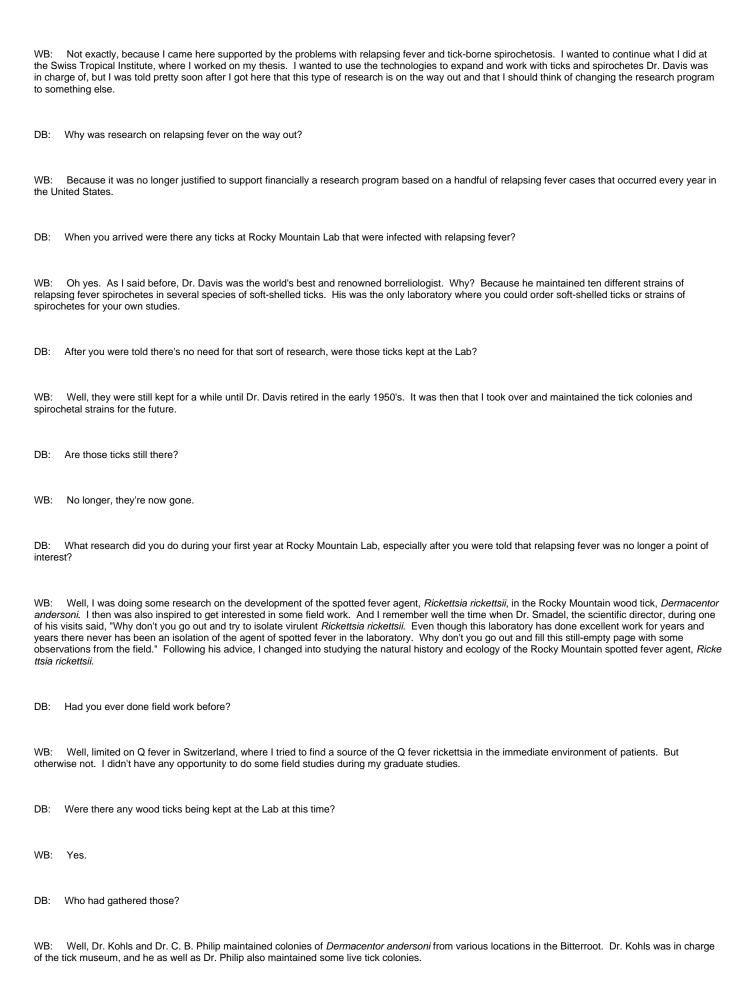
WB: known	I hat's correct. He was doing pioneering work along with Dr. Cox on the isolation of the first strain of Q fever in the United States, but he was bette in for his work on spirochetes and relapsing fever.
DB:	And you were familiar with his work through your graduate studies?
WB:	That's correct.
DB:	How did it come about that you got a fellowship at Rocky Mountain Lab?
WB: visit D genera	Professor Geigy was a close friend to Dr. Parker, the Director of the Rocky Mountain Laboratory. Geigy visited Dr. Parker in 1948, and during his r. Parker promised him a fellowship for one of his students, a student who would like to expand his studies on tick-borne diseases or on ticks in al.
DB:	And you were the student, I take it.
WB: mosqu	Yes, I was the one one of two. One of the graduate students of Professor Geigy received a fellowship to work on DDT campaigns against uitoes in Sardinia, and the other could go to the Rocky Mountain Laboratory to study ticks.
DB:	And how did you end up being the man who came to the Rocky Mountain Lab instead of Sardinia?
WB:	There was a kind of betting among my friend and myself, and I lost. He decided to go to Sardinia; I had to go to Rocky Mountain Lab.
DB:	When you say "betting," what kind of betting was this?
WB:	We threw up a Swiss franc, heads or tails.
DB:	And you lost.
WB:	I lost.
	When you set out for the Rocky Mountain Lab in Hamilton, Montana, did you know anything about the Lab history of research on tick-borne ses other than the Q fever research that you had worked on when you were in Switzerland?
	Oh yes. I mean, the Rocky Mountain Laboratory was very closely associated with the research of Dr. Ricketts on spotted fever. Dr. Davis was ig on tick-borne relapsing fever. Dr. Eklund and his group were working on encephalitis virus, so these studies were known, not in detail, but at leas that they were going on. Also studies on tularemia.
DB:	These were studies that were accessible to you as a student in Switzerland.
WB: not su	Yes, and there were also some news media. I recall a colored magazine about the Rocky Mountain Laboratory I think it was in 1950 or 1949, I'm re That had pictures of the Laboratory, not only of its investigators, but also of the building, so I knew a little bit when I got here.

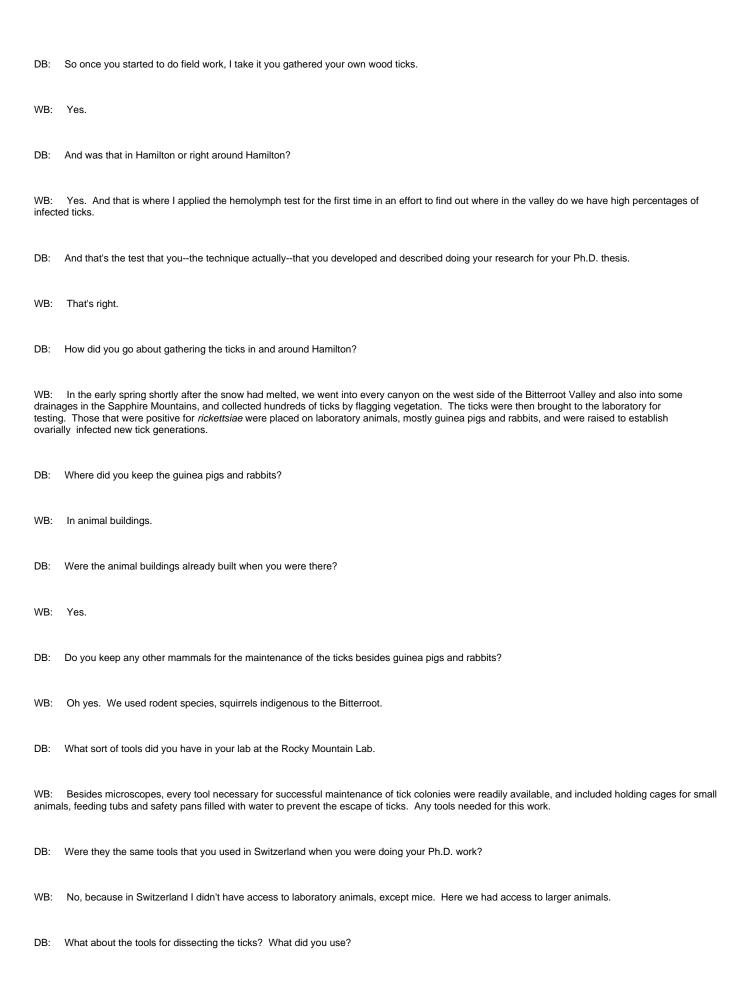
DB: Other than those exposures, did you know anything at all about Montana?



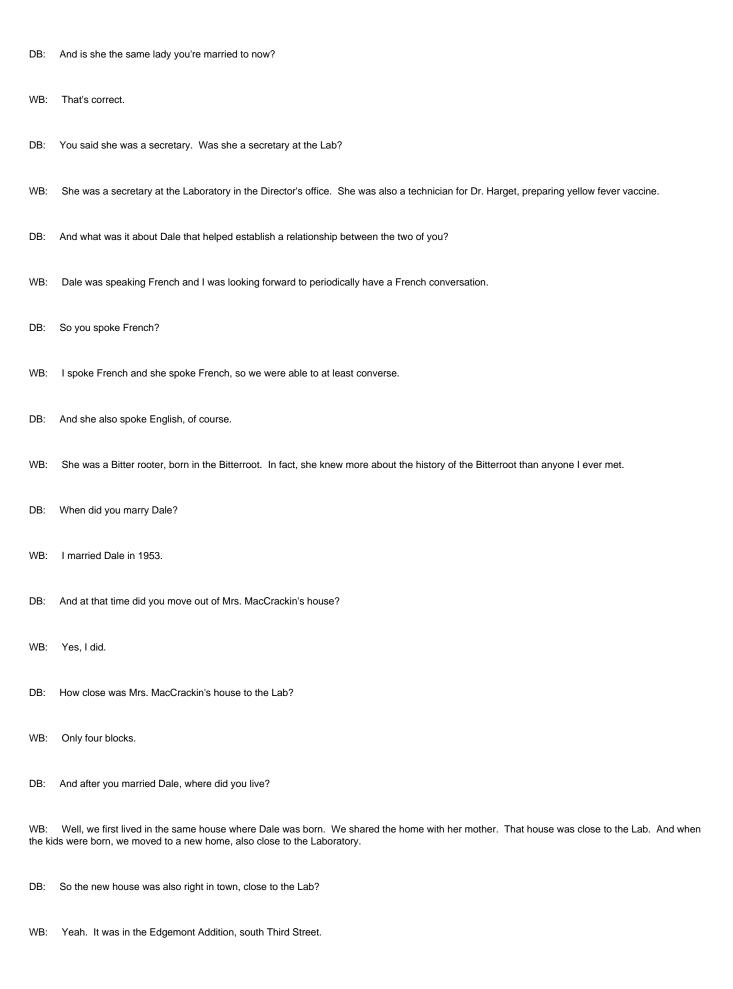
who w	Yes, the Director then was Dr. Carl Larson, who had to approve my application for a second year of the fellowship. The other one was Dr. Philip was interested in the development of pathogens in tick vectors, exactly the same subject I was interested in, not only on relapsing fever but also on pathogens such as <i>rickettsiae</i> .
DB: Visitin	You've already said that you had an opportunity to extend your period, your work period here beyond the first year, and you did that you said as a general scientist?
WB:	Right.
DB:	What were your duties at Rocky Mountain Lab, both as a Fellow and then as a Visiting Scientist?
WB: fever,	There was no difference. I needed my research programs accepted by the peers, like Dr. Larson and Dr. Davis. They were initially on relapsing and then later, on other pathogens such as <i>rickettsiae</i> .
DB:	Did you still have family living in Switzerland at the time that you first went to the Rocky Mountain Lab?
WB:	Yes.
DB:	Did you keep in contact with them?
WB:	Yes.
DB: tell us	You've already mentioned some of the research that was being done at Rocky Mountain Lab on tick-borne diseases when you arrived. Could you and I know some of this would be repetitious, who was doing that work on tick-borne diseases?
WB: on Q	Dr. C. B. Philip and Dr. John Bell were working on various rickettsial problems. Dr. H. Stoenner, Dr. L. Luoto and Dr. R. A. Ormsbee were working Fever; and Dr. C. Eklund was working on Colorado tick fever.
DB:	Did you start working with these people or were you working by yourself?
	Whenever I could pick up some technology and some knowledge from some of these colleagues, I took advantage of it, especially Dr. Eklund g a lot about viral diseases and about viral technology, Dr. Philip also. So I didn't only work for myself. I had my own projects, but I always nunicated with other staff members.
DB:	Did the scientists that worked on tick-borne diseases have a group or a unit name?
WB: curato	Yes. They were called entomologists in a broad sense, and those working with ticks only were referred to as acarologists. Dr. Glen Kohls was the or of the tick collection at the Rocky Mountain Lab.
DB:	When you first came to Rocky Mountain Lab, were there any other foreign scientists here?
WB: and e	Yes, there was another Swiss, hooray! His name was Dr. Edgar Ribi, who came about three months before I did, and was working on tuberculosis lectron microscopy of pathogens such as the agent of tularemia.

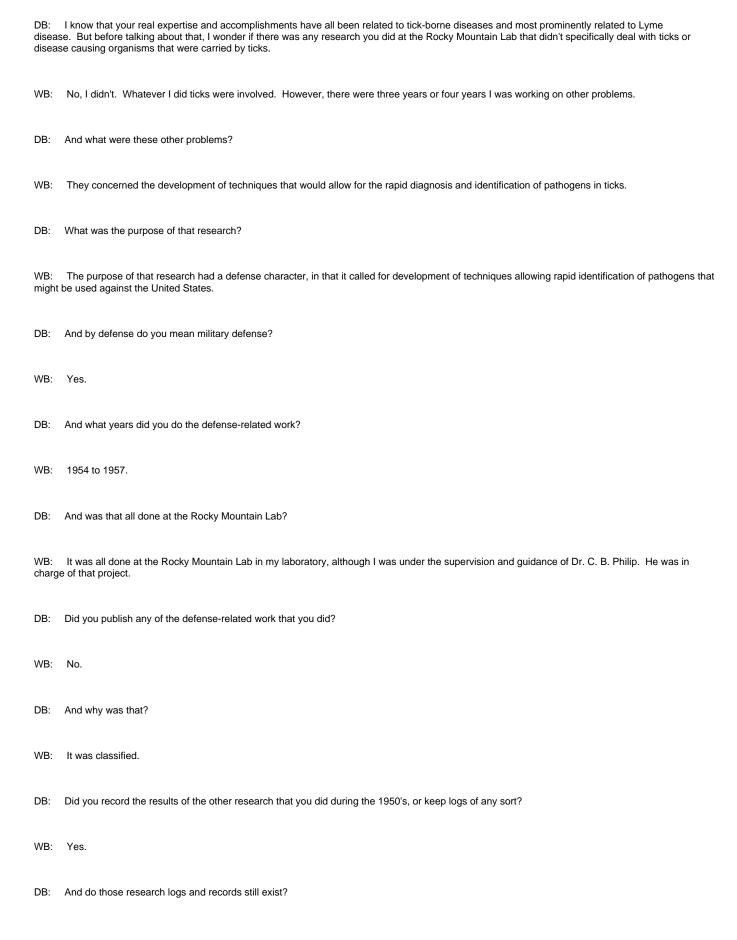


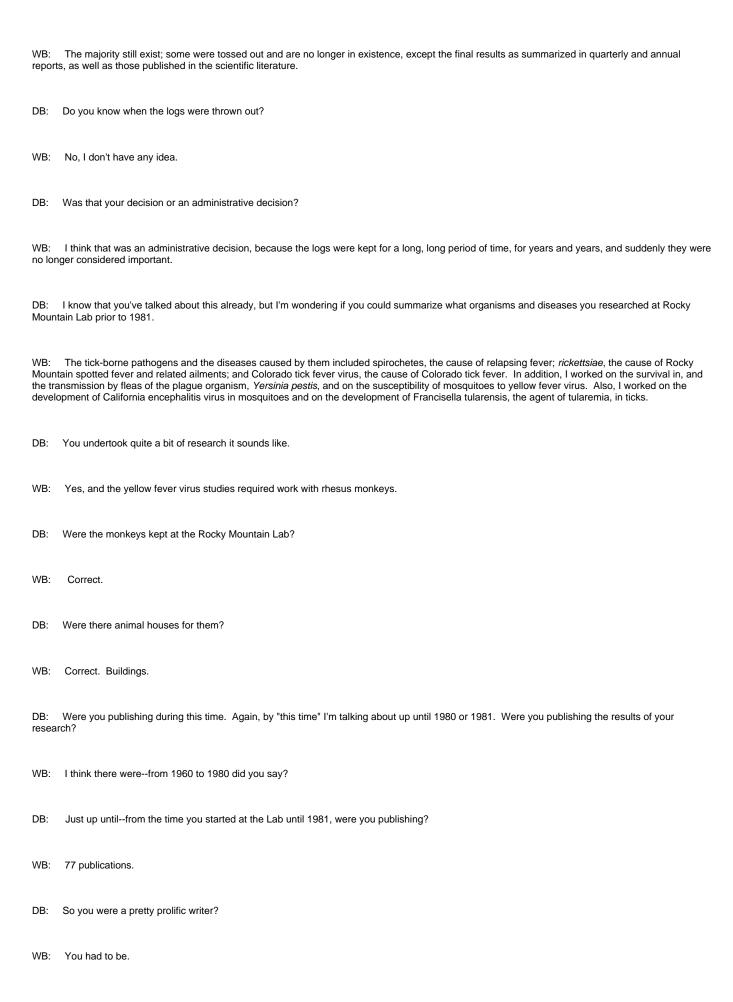












DB:	When you say you "had to be," why is that?
WB:	Dr. Larson always said you do a good job here if you have at least three publications per year. Anything below means, "Get going."
DB:	So you published at least three articles a year? Did you publish all of these articles in English?
WB:	Most of them in English. One was in French, and I don't know, two or three were in German.
DB:	Did you have trouble writing articles in English when you first started doing that?
WB:	English problems.
DB:	How did you overcome those problems?
WB: way.	By learning English or trying to learn English. The American way of reporting, writing scientific articles, was completely different than the Europear The Europeans like to expand and to put some color into their publications, whereas the Americans are cut and dry.
DB:	Did your colleagues help you write the American style?
WB:	Yes. I think I still have the first manuscript I submitted to my colleagues and they took every word apart.
DB:	And so did you put it back together the way that made it a successful article?
WB:	Yeah.
DB:	And I take it this got easier and easier the more you did it?
WB: about.	Of course. The more you are writing, the more experience you get. I often refer to the "red line" running through the subject you are writing. Stick to the red line, you will produce a good paper. Deviate from it, and you will lose the reader's attention.
DB: early o	In addition to the articles that you've had published and the records that you made and the logs you made of your work, that is the logs that you did on, did you maintain any records of your research effort from the 1960's and 70's through 1980?
WB:	Oh yes.
DB:	Do you still have any of those records?
WB:	Yes.
DB:	Do you keep them at the Lab?

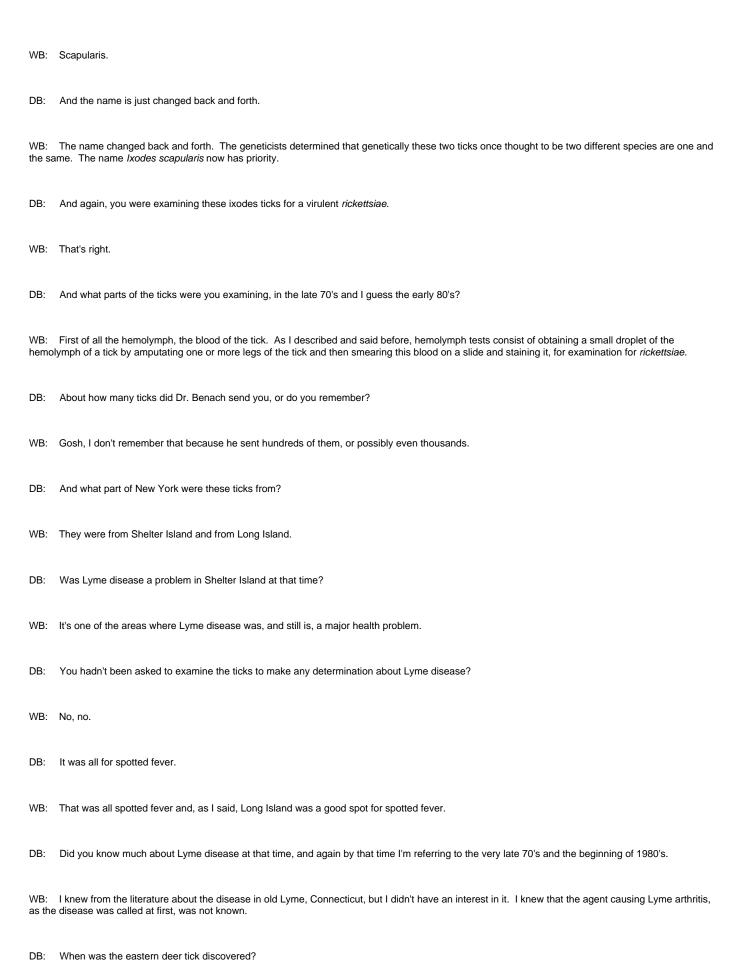
WB:	Yes. They are in my files at the Laboratory.
DB:	Do you know what ticks live in Montana? How many ticks you think live in Montana?
WB: ticks.	No, I don't, and I don't think anyone else does. We know the ticks involved in maintaining and distributing pathogens, such as the wood and rabbit A thorough study of the ticks of Montana, to the best of my knowledge, has not been made.
DB:	So that's work that needs to be done or could be done.
WB:	It could be done. I doubt that it would get wide support, unless a new disease emerges with completely different species of ticks involved.
DB: relaps	When you began your work at Rocky Mountain Lab, had the organisms that cause Colorado tick fever and Rocky Mountain tick fever, as well as sing fever, all been identified?
	Yes, they had been identified, let's say representatives of these agents had been identified, but thorough studies of either of those agents had only done during recent years. The natural history of spotted fever had been initially worked out by Dr. Ricketts at the turn of the century. But strain ons and isolations of different <i>rickettsiae</i> and different viruses and so on had not been done in those days.
DB:	Could these organisms be cultured when you started work here?
Dr.	Yes.
DB: the we	You've already told us that the organism that causes Rocky Mountain spotted fever and <i>Rickettsia rickettsii</i> , and you said that is usually carried by cod tick. Is that right?
WB:	Yeah, the Rocky Mountain wood tick, <i>Dermacentor andersoni</i> .
DB:	Are all wood ticks infected with <i>rickettsiae</i> ?
WB: siae. patho	No. Only about 2 to 3 percent of the ticks in the Bitterroot Valley on the west side of the river are infected with virulent strains of spotted fever <i>rickett</i> There are 15 or even higher, 20 percent of ticks that maintain <i>rickettsiae</i> or <i>rickettsial</i> agents that are not virulent for humans, they are nongenic.
DB:	Are there ticks other than the wood tick or is there any other known carriers of Rickettsia rickettsii?
WB: nature	Yes, there are different species of ticks, like the rabbit tick, <i>Haemaphysaiis leporispalustris</i> , that are involved in maintaining rickettsial strains in throughout the United States.
DB: basica	You indicated that when you were determining whether or not wood ticks were infected, you used some of the same techniques and procedures, or ally the same techniques and procedures that you had used in Switzerland when you were examining the ticks from Africa. Is that right?
WB:	Yes.
DB:	And is that the same technique you would use now if I were to give you a tick and ask you if it was infected?

WB:	The only one, and the most dependable one.
DB:	And is that the same technique that somebody else would use if they were capable of determining whether a tick was infected?
WB: manife	Yes. If you have a tick on your head and give me the tick in half an hour I can tell you whether or not you have to watch out for clinical stations that could be spotted fever or something else.
DB:	And in fact many people in Hamilton do end up with a tick on their head and do want to know if it's infected. Isn't that true?
always tick" a	It certainly is. In most instances the ticks I examined off people were negative for <i>rickettsiae</i> . When people were bitten by positive infected ticks, I is referred the victims to their physicians for observation and treatment. Throughout my career, I emphasized that there is no such thing as a "normal and that a negative test does not rule out the presence of undetectable pathogens such as viral agents. Sometimes the ticks I examined were dead nat people had crushed in efforts to get rid of them.
DB:	And that makes it harder for you to determine whether there's a viral, or a detectable agent in it?
WB:	That's right.
	How much work had you done before 1981 to determine whether ticks or tick populations were infected with agents that cause Rocky Mountain d fever?
Tenne	A lot of work. In those years, we had expanded our survey research and educational programs for people to other areas such as Mississippi, ssee, South Carolina, Ohio, and Connecticut. These are states reporting cases of spotted fever every year. And we initiated educational programs ticks – how to prevent them and how to safely remove them once attached.
	Continuing the interview with Dr. Burgdorfer on July 13, 2001 in Hamilton. Dr. Burgdorfer, I know we've talked about this already a little bit, but you tell us or tell us again, whether the organisms that cause Rocky Mountain spotted fever and the organisms that cause relapsing fever, are similar way, just to look at them.
WB: microd	Just to look at them, the answer is no. Rickettsia are short rods bacteria. The spirochetes are also bacteria but they are coiled, long organisms, and there is no doubt that anyone can differentiate these organisms based on their morphology alone.
DB:	Obviously not anyone can tell the difference, but you certainly can. Is that true?
WB:	Yes.
DB: awful l	And by 1981, I take it just from what you've told us during this interview, you had looked at an awful lot of spirochetes and you had looked at an ot of <i>rickettsiae</i> . Is that true?
WB:	Correct.
	In the case of the ticks that you studied up until 1981, had your research contributed to cures or prevention of tick-borne diseases, and again I that we've touched on that already, but I'd like you just to talk about whether or not, first of all, your research has contributed to cures for any tick-diseases?

WB: Not exactly for cures, but certainly for the education of the general public and of physicians in an area in which Rocky Mountain spotted fever is prevalent. As I mentioned, we did tick surveys in various states, Mississippi, Tennessee, South Carolina, Ohio and Connecticut, to identify the areas with a high incidence, not only of spotted fever, but also of infected ticks. And along with these tick surveys went educational activities to educate the general public about ticks and about the prevention of tick bites and prevention of disease.		
DB:	So do you consider education the main preventive mechanism for tick-borne diseases?	
	That's correct. The education is the best means of preventing a tick-borne disease. Once you know how ticks look like, you recognize them right and can remove them properly; and then the chances of getting sick are not as great.	
DB:	Dr. Burgdorfer, what sort of work schedule did you have at Rocky Mountain Lab when you first came there?	
	When I first came it was from 8:00 o'clock in the morning until 12:00, and from 1:00 o'clock until 5:00. Then they changed that from 8:30 to 12:00, from 12:30 until 4:30.	
DB:	Did you ever work beyond that schedule?	
WB:	Probably all the time.	
DB:	But those were the official hours?	
WB:	Yeah.	
DB:	When were you actually at the Lab?	
WB: 1:30 a	I usually went to the Lab between 8:00 and 9:00 o'clock in the morning and worked there until noon, but then in the afternoon I started around 1:00, and worked many, many, many days until midnight, just depending on the amount of work that needed to be done.	
DB:	It sounds like you were especially interested and intrigued by the work you were doing. Is that a fair statement?	
day w	Yes, and once the tick material was sent to us, we had to work it up immediately to prevent a lot of those ticks from dying. Many times eight hours a ras just not enough to take care of all the material, because in many instances physicians who did send in ticks for examination wanted to know the s and I'll put that into quotes, "often before we got the ticks."	
DB:	And it's something you couldn't just let lie, I take it.	
WB:	That's right.	
DB:	Were there any changes at the Rocky Mountain Lab prior to 1981 that affected your work there in any way?	
patho	No, there were no changes as yet, although by that time I began to realize that molecular biology and the new sophisticated molecular techniques ecame available, were completely different than the laboratory techniques we used in determining infection in ticks or the development of the gens in ticks. And these changes, especially in genetics and molecular approaches to the problems, some of us, myself included, were not olded, we were not educated in using these approaches.	

DB: and w	DB: And going back to your education and schooling, specifically with Dr. Geigy, did you maintain contact with Dr. Geigy after you became an Americ and were fully established at the Rocky Mountain Lab?		
WB: every	Yes, certainly I did. I kept him informed of what I was doing and how the work was coming along. I would say two, three letters, detailed reports, year.		
DB:	And did he write back to you?		
WB:	Yes, yes he did, and many times he had some suggestions as to the research direction in which we should go.		
DB:	Were these good suggestions? Were they pertinent to what you were doing?		
	Yes, because Professor Geigy, as I mentioned before, was not only a professor in zoology, but he also loved the work on tick-borne diseases, ially African diseases, not only tick-borne, arthropod-borne in general. He was interested in my research program.		
DB:	So you maintained a pretty close relationship with Dr. Geigy.		
WB:	Yes, very close.		
DB:	How long did you maintain that relationship?		
	Until Professor Geigy retired and could no longer maintain the connection with some of his students. Maybe one letter a year was just about all you om him, or cards telling you that he enjoys skiing in Switzerland and that he has retired and is no longer up to par with the scientific advances.		
DB:	Do you remember how old he was when he retired?		
WB: No, I don't exactly remember, but his students, including myself, honored him at his 80th birthday with a symposium on spirochetes and tropic diseases. He enjoyed his retirement in Switzerland until he died.			
DB:	Do you remember what year he died?		
WB:	It was about five years ago. He was 94 years old.		
DB:	So did you maintain some contact with him until his death?		
WB:	Let's say until about two or three years before his death.		
DB:	Have you kept the letters that Dr. Geigy wrote to you during this time period?		
WB:	Yes.		
DB:	And where do you keep those?		

WB:	I keep them in my personal files.	
DB: or mos	Getting into your discovery of the spirochete that causes Lyme disease, first of all, would you say that this is the work that you were most famous for st known for?	
WB: whene	Right now probably this is true. Before that, I had a reputation as, let's say, I think I mentioned it once before, "tick surgeon," meaning that ever when I got any ticks in for examination to see whether they were infected, I always did a thorough sectioning.	
DB:	And again I think you said there probably isn't anyone else in the world who has dissected as many ticks as you. Is that probably so?	
countr	I think that's a safe statement to make, although there are several research laboratories, especially associated with state health departments in this y where tick examination, the way I used to do it, is also being practiced, because it's the state health officers who emphasize getting tick material for nation, especially where human patients are concerned.	
DB:	So those health officers are using the same techniques that you used.	
	Yeah, they have technicians that are following very similar steps, although I have to emphasize that today, of course, you've got PCR and other ular techniques that are much faster and just as exact as what we used to do with the ordinary microscope and ordinary techniques.	
DB:	And those are the same techniques that you were using when you were a graduate student in Basel.	
WB:	Correct.	
DB:	Going ahead to your work with Lyme disease, can you remember when you first examined eastern deer ticks?	
WB: Yes, I can, but I have to mention the background of that examination. It goes back to the year 1977 when I started to collaborate with Dr. Benach from the New York State Health Department. The objectives were to recover virulent strains of <i>Rickettsia rickettsii</i> from the dog tick, <i>Dermacentor variabilis</i> , which is the vector of spotted fever along the Atlantic seaboard. We wanted to get virulent strains of these agents from the immediate environment of patients. In the years '71 to '76 there were 124 spotted fever cases with eight deaths in New York State. So we thought that collections of ticks from the immediate surroundings of these patients would provide us with virulent strains of <i>Rickettsia rickettsiii</i> . Although we did find six percent of the ticks infected with <i>rickettsiae</i> , none was of the virulent type. They all were found to be <i>Rickettsia montana</i> , a non-virulent rickettsial species that does not produce human disease. So we started to speculate maybe there were other ticks in that area that were responsible for maintaining and distributing spotted fever <i>rickettsiae</i> . The only tick we could think of, a tick that appears abundantly in those areas, was the eastern deer tick, which at that time was called <i>Ixodes scapularis</i> , but the name of which was changed, so that it became known as <i>Ixodes dammini</i> . The tick is now again recognized as <i>Ixodes scapularis</i> , since the two species, <i>dammini</i> and <i>scapularis</i> have been found to be co-specific, or one and the same. The first pool of ticks submitted for examination arrived in 1979.		
DB:	When you say he submitted the first pool of ticks for examination, does that mean he sent them to Hamilton for you to examine?	
	That's correct. He and his co-workers collected the ticks off vegetation in the neighborhood of patients, and then he forwarded them to me for nation by hemolymph testing. We did find <i>rickettsiae</i> in high percentages, of ticks, but they all were of the non-virulent <i>Rickettsia montana</i> type.	
DB:	Prior to receiving the pool of ticks from Dr. Benach, had you examined eastern deer ticks?	
WB:	No.	
DB:	And just to avoid confusion later, in your publications when you talk about <i>Ixodes dammini</i> , you're talking about the <i>Ixodes scapularis</i> .	



WB: Oh gee, there are records in the literature that this tick was seen in the early 1700s and was a considered a nasty parasite for the pioneering people. And from what you've already told us, it sounds like by 1981 it was not known that the eastern deer tick was the carrier of the agent they called Lyme disease. WB: That's correct. It was not known. It was suspected by the people in Connecticut that ticks may be involved in maintaining and distributing whatever causes the disease. DB: And did anyone know what it was that caused the disease? Again the disease being what was called Lyme arthritis. WB: No. Not at that time. DB. Were there any theories before 1981 about the actual agent that causes Lyme disease? WB: Not in this country. In Europe, yes. In Europe, what is now known as Lyme disease was referred to as erythema migrans, which is a period of manifestation of the disease in form of lesions appearing on the skin. In 1909, the Swedish physician Dr. Arvid Afzelius presented to the Dermatological Society in Stockholm, Sweden, an annular skin lesion at the site of a previous bite by the sheep tick, Ixodes ricinus - the most common tick in Europe. Because of the characteristically expanding or "migrating" ring on the skin surface, Afzelius named the disorder, Erythema migrans. It was also called Erythema chronicum migrans, or ECM because in some patients, the erythema lasted as long as six months. The cause of ECM was unknown although the sheep tick was suspected as the vector of whatever caused the disease. DB: When was this theory developed? WB: As early as 1909, there were publications on ECM. DR: And had you read those publications by 1981? WB: Well, by 1981 I knew of them, particularly of a paper by Dr. Hellstrom of the Karolinska Institute in Sweden. In 1949, Dr. Hellstrom presented a talk entitled, "ECM Afzelius with Meningitis," at the 43rd annual meeting of the Southern Medical Association in Cincinnati. He not only reviewed the number of cases in which after tick bites, both Erythema migrans and subsequent meningeal symptoms occurred - he also reported on the successful administration of penicillin in the treatment of ECM. He also presented his thoughts on the still unsolved etiology of ECM. Unfortunately, no one followed up on this work. DB: There was no follow up on the Swedish scientist? WB: There was no follow up on it. DB: And was there any suggestion at that time that the agent was a spirochete? Dr. Hellstrom pointed out that circular erythemas subsiding in the center and advancing peripherally may occur not infrequently in association with spirochetal or other infections. He concluded that "it seems reasonable to raise the question of whether ticks are carriers of spirochetes with allergizing – and immunizing – properties." Unfortunately no one followed up on his speculations. DB. So, again there was no scientific follow up on that suggestion?

There was no follow up at all by anyone.

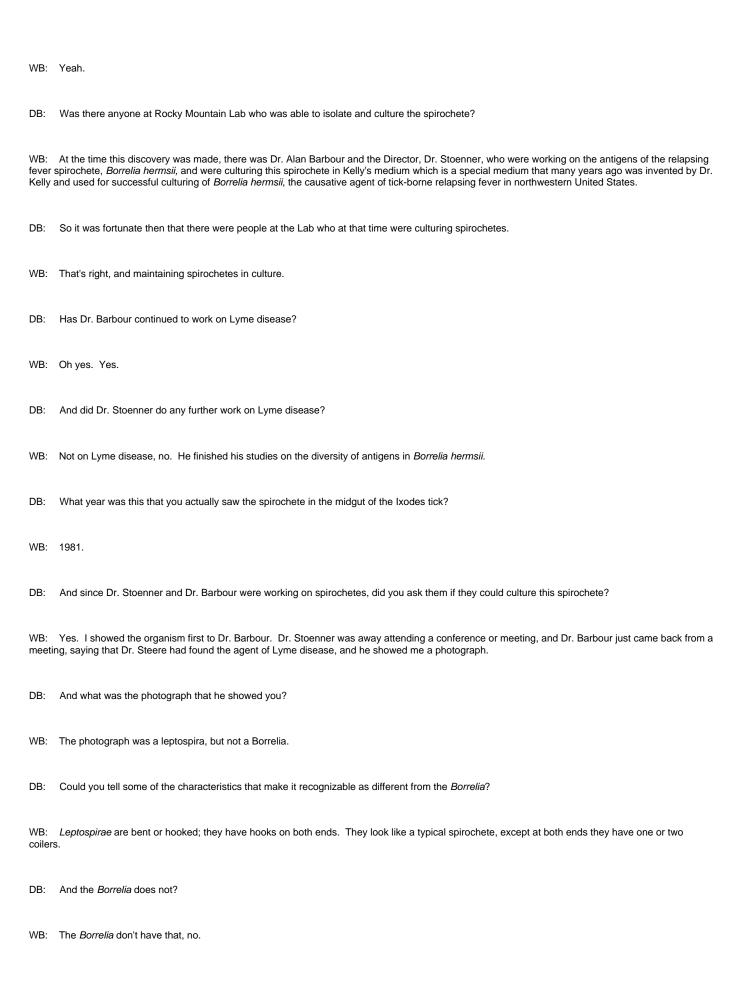
WB:

DB:	And again, it sounds like prior to 1981 you weren't giving any serious thought or you weren't doing any research on Lyme disease.
WB: patho	No. I helped and I informed Dr. Steere and his medical entomologist, Dr. Main, about techniques involved in determining whether or not a gen is present in the tick population in Connecticut.
DB:	Could you just briefly explain who Dr. Steere was?
WB:	Dr. Steere was the health officer who was asked to investigate the strange cases of rheumatoid arthritis occurring in Connecticut.
DB:	So he thought that the disease might be transmitted by a tick and he wanted to know how to examine ticks?
WB:	That's correct.
DB:	And did you tell him how to examine a tick?
WB:	Of course. We had two two-hour-long discussions with step by step instructions.
DB:	So you gave them detailed instructions on how to dissect ticks?
WB:	Yes.
DB: cause	Going back to the ticks that Dr. Benach sent you from Shelter Island, when you were dissecting those ticks you were looking for the bacteria that s Rocky Mountain spotted fever, and you said you did find some rickettsiae, is that right?
WB:	Yes.
DB:	That it wasn't virulent for the most part?
WB:	Yes.
DB:	And were you examining these ticks the way that you examined ticks in the past?
WB:	Correct. We first subjected them to the hemolymph test to determine whether they were infected with <i>rickettsiae</i> . That was our prime objective.
DB:	And you told us you found rickettsiae that weren't virulent. Did you find anything else in these ticks?
WB:	Yes.
DB:	And what was that?

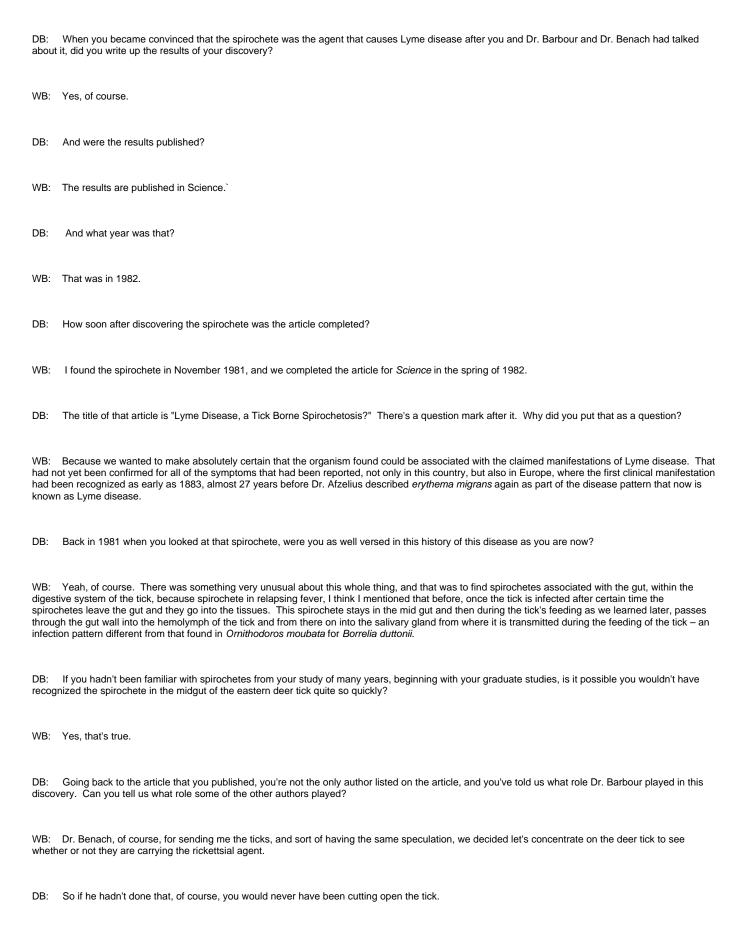
WB: There were two female ticks in whose hemolymph I noticed the presence of microfilaria – the young stages of a nematode – similar to microfilaria had seen before, in the hemolymph of the European sheep tick, <i>Ixodes ricinus</i> . I now wanted to know whether these microfilaria occurred not only in the tick's blood – or hemolymph – but also in other tissues. I dissected both ticks and prepared tissue smears from each organ for microscopic examination. There were no additional microfilaria, but instead I detected in the midgut of both ticks large numbers of faintly stained, slender, snake-like micro-organisms that I recognized right away as spirochetes.		
DB: that.	Before you found the spirochete it sounds like this examination was sort of a bust. You looked in the blood for virulent <i>rickettsiae</i> , you didn't find Then you found a nematode and you didn't find that.	
WB:	Right.	
DB:	And then you did find what was a spirochete. And in what part of the tick did you find the spirochete?	
WB:	It was only in the mid gut.	
DB:	In the midgut.	
WB:	That's right, in the digestive system, because it's part of it.	
DB:	And did you at first find just one spirochete or several?	
	Several. Of course, there were clumps of them. The original photograph of what I saw shows about three and four individual organisms; another graph shows clumps of spirochetes.	
DB:	And by the photographs, you're talking about photographs that you	
WB:	That I took.	
DB:	After you found them, did you recognize these clumps of organisms immediately?	
also s took a	Yes. Once my eyes focused on these long snake-like organisms, I recognized what I had seen a million times before: spirochetes. Right away I peculated that this may be what the Europeans are talking about or speculating about. Next, I wanted to make sure that it was a spirochete; so I a little drop of the midgut, put it under the dark field to see whether the organisms were alive and whether they showed the typical movement of chetes – a characteristic rotational and translational movement.	
DB:	Again, you had a lot of experience looking at spirochetes, starting with your graduate work. Is that right?	
WB:	Yes.	
DB:	And you were certain that it was a spirochete. Is that right?	
WB: move	Yeah. Once I put it under the dark field, then I saw the movement, the activity of the organism—characterized by translational and rotational ment.	

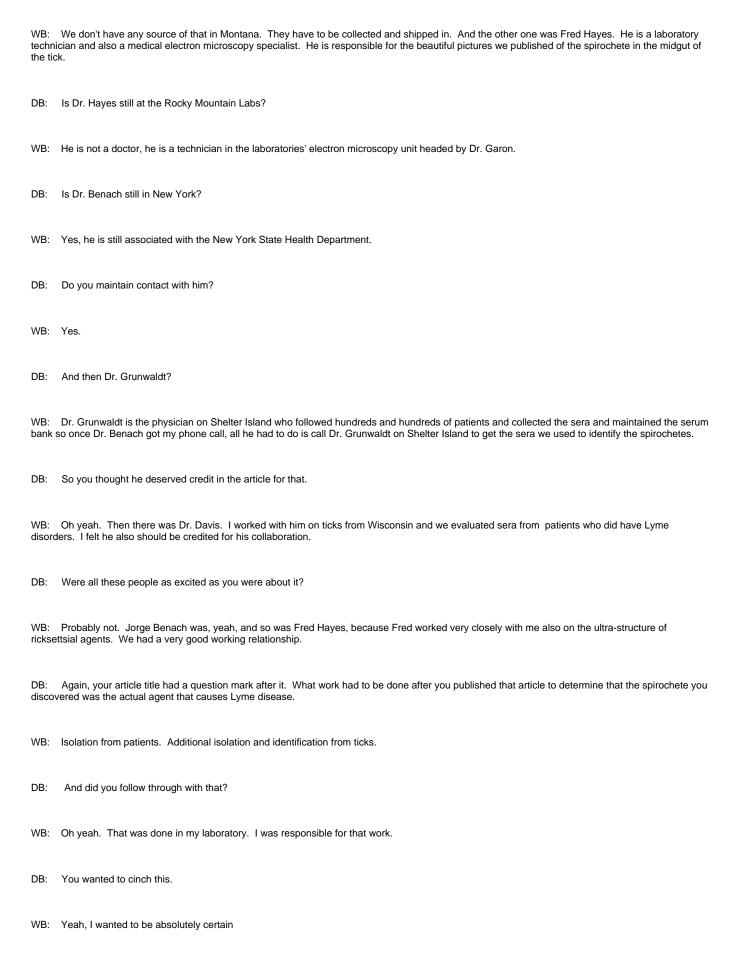
DB:

You were certain?



DB:	So you knew that it was different from what you had found in the midgut of the Shelter Island tick?.
	Yeah, I told Dr. Barbour, "What you're showing me here is a leptospira and if Dr. Steere says this is the agent of Lyme disease, he is wrong." Of st is the fact that Dr. Steere isolated his <i>leptospira</i> from a Lyme disease patient.
DB:	But you knew it wasn't the same critter that you had discovered?
WB:	That's right.
DB:	Dr. Barbour and Dr. Stoenner then went about culturing your spirochete. Is that right?
	Dr. Barbour did. I suggested and invited him to cultivate or to try to cultivate and isolate this spirochete. I gave him three infected ticks from which cceeded in isolating and culturing the organism.
DB: diseas	What further work did you or you and Dr. Barbour do to determine whether or not the spirochete that you discovered was the cause of Lyme se?
refrige	Within hours after I detected this organism, I asked Dr. Benach to approach Dr. Grunwaldt – a physician on Shelter Island who had in his erator numerous sera from acute and reconvalescent Lyme disease patients – to send me some for indirect fluorescent antibody testing. When the were positive, we knew we were dealing with the causative agent of Lyme disease.
DB:	You said you did this within hours, it sounds like you were quite excited about this discovery.
WB:	Yes, quite excited.
DB:	And was Dr. Barbour excited?
WB:	Yes, of course he was, because he also knew, as I did at that time, that everyone is looking for the agent of Lyme disease.
DB:	Why was everyone looking for the agent that caused Lyme disease in the '80s?
	Initially, Dr. Steere described the disease as a new form of arthritis. He soon learned that many patients suffered not only of arthritis, but also of ders affecting the skin, muscular, cardiac, and nervous systems. Thus, he changed the name from Lyme arthritis to Lyme disease.
DB:	Are these symptoms that you're talking about painful to the patient?
WB:	Yes, some are.
DB:	So it was a public health problem at that time.
	Yeah, oh yeah, it was. Of course all of these forms described by Dr. Steere and his colleagues, already were in the literature in Europe because were described there also as individual diseases because no one knew that the spirochete was the cause of all these manifestations.



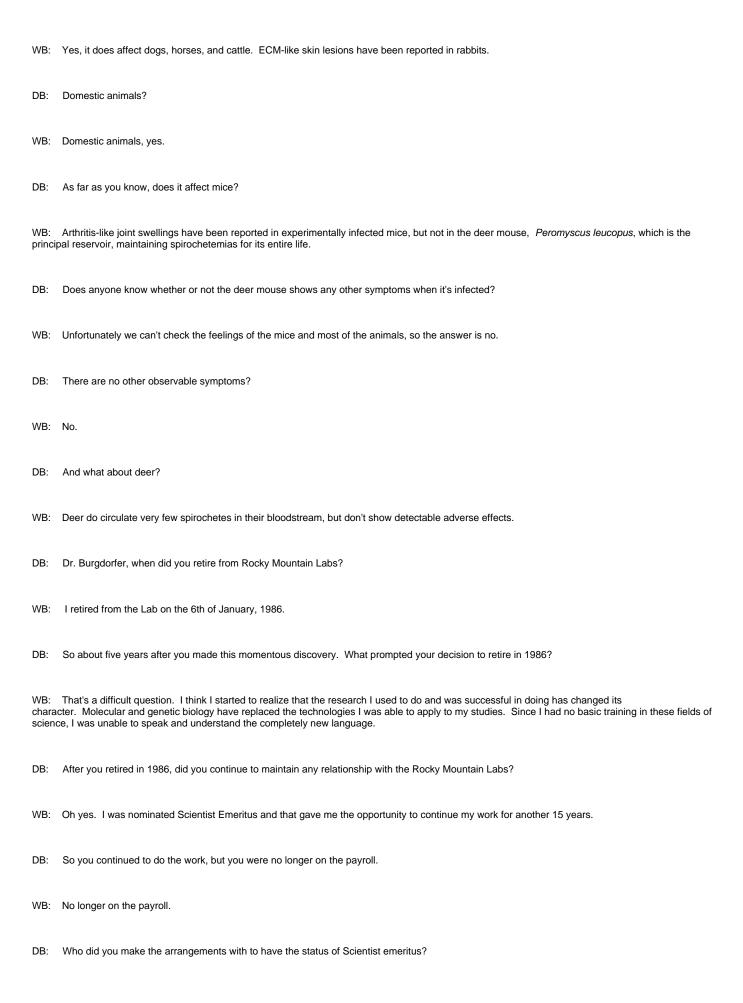


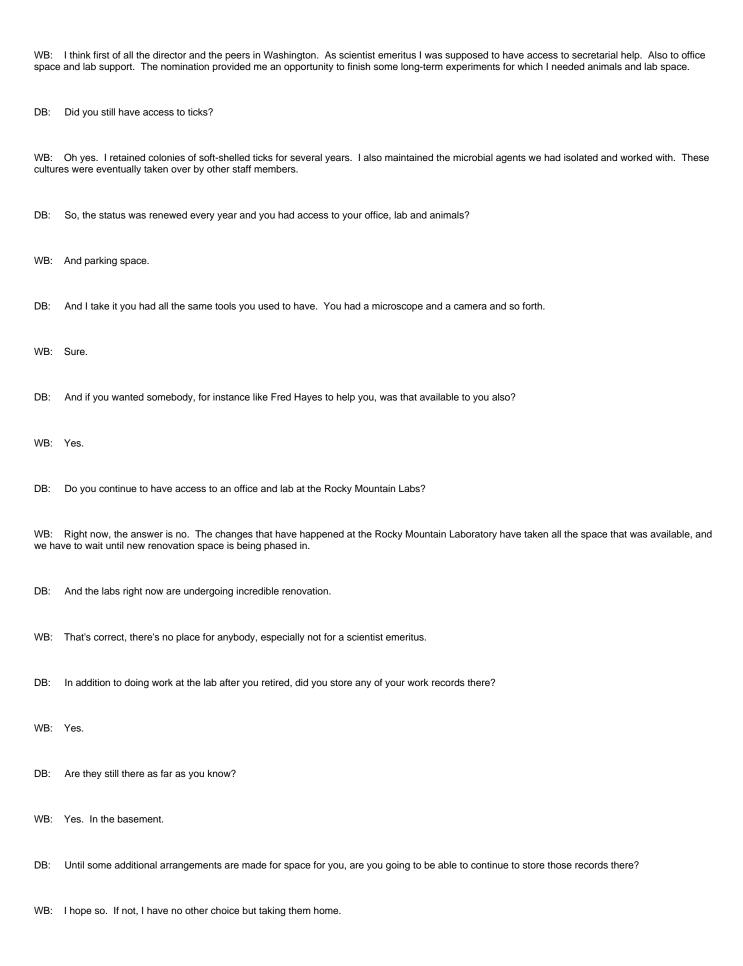
DB:	Was the spirochete that you discovered a new spirochete as far as you could tell?
WB:	Yes.
DB: new?	And one thing that made it new to you, of course, is that it was a Borrelia dwelling in the midgut of an ixodid tick. Is there anything else that made it
	Of course. Also new was the wide spectrum of clinical manifestations caused by this spirochete. It was soon found to affect the ski, blood, muscle, nd neurosystems with problems usually described for tick-borne spirochetes.
DB:	Did you collaborate with additional people to do your follow up work that cinched the fact that this spirochete was the cause of Lyme disease?
compa the fire	Dr. Russell Johnson of the Microbiology Department in the University of Minnesota, offered to work up the genetic material of this organism and are it with the other Borrelia that are known. He found that it was a completely different organism that deserved a different name. Thus when during st international symposium on Lyme disease held at Yale in 1983, the question was posed how to name this organism, the majority of my colleagues d to call it <i>Borrelia burgdorferi</i> .
DB:	Because your last name is Burgdorfer.
WB:	It was named after the one who discovered it.
DB:	When a new microorganism is discovered, generally speaking, is there a standard procedure for giving it a name?
WB:	Yes.
DB:	And what is that procedure?
	The main procedure is to determine genetically the DNA composition of the organism. Molecular, and also physiological, studies are required a new name is given according to the standards of the International Systematic of Bacteriology.
DB:	So this organism would have been called Borrelia something, is that true?
	Yeah, it would have been. If for instance, the majority of my colleagues would have rejected the name <i>Borrelia burgdorferi</i> , it could have been d according to someone or something else.
DB:	But it would have been called "Borrelia" something?
WB:	Correct.
DB:	So this is quite an honor to have it named after you.
WB:	Oh yes. An exciting honor.

DB:	And is it fair to say that this discovery is what you are most famous for?
WB:	Now I wouldn't say famous. Let's call it "known for".
DB:	"Known for", all right.
WB:	There are other things I'm known for.
DB:	But there's nothing else that has been named after you, is there?
WB:	No.
DB:	Are there any ticks that live in Montana that are known to carry Borrelia burgdorferi as far as you know?
WB:	No. As far as I know, no.
DB:	Has anyone done any work on that?
anima work a	No. There is no complete compiling of ticks from Montana, and the Ixodes species that we have are all very closely associated with the host il. It is quite possible that a spirochete similar to, if not identical with, <i>Borrelia burgdorferi</i> may be maintained in the wild, but nobody has done any along this line. As far as I know, there has never been a case of Lyme disease in Montana. The only cases seen in Montana are those that have contracted back east in areas where Lyme disease is present.
DB:	Has there been any work done to determine whether or not the eastern deer tick could survive in Montana?
surviv	I don't think work has been done and I don't think it's necessary. You may have areas where the humidity conditions are such that the tick could e. The most important thing for <i>Ixodes scapularis</i> for survival is high humidity. It's too dry in Montana for these ticks to survive for a long period of However, as I say that, in Utah, north of Salt Lake City in the Wasatch Mountains are conditions that allow for the survival of infected <i>Ixodes pacificus</i> tis not surprising that a few Lyme disease cases have been recorded from that region.
DB:	So these little niches I take it are humid. Is that true?
WB:	That's right, otherwise the ticks could not survive.
DB:	And when you say they're infected, are they infected with Borrelia burgdorferi?
WB:	Yes. They're related. Very closely related, and they still call them Borrelia burgdorferi, but there may be some additional sera types.
DB: that w	Do you have any ideas or theories or thoughts on what would make the spirochetes from those ticks in Utah a little bit different from the spirochetes ere found in New York? Is it possible that the variations are caused by the environment?

WB: It has long been speculated that introduction of <i>Borrelia burgdorferi</i> into geographic foci with tick vectors and animal hosts different from those in endemic areas may lead to genetic as well as physiologic variations of these microorganisms. Such variations have been reported from ticks and tick hosts, but so far, not from humans as patients. In Europe, molecular and immuno-chemical analyses of spirochetes from ticks – from <i>Ixodes ricinus</i> ; from host animals and humans, have classified <i>Borrelia burgdorferi</i> into three geno-species: <i>Borrelia burgdorferi sensu strictor</i> , <i>Borrelia garinii</i> , and <i>Borrelia afzelii</i> . <i>Borrelia burgdorferi</i> is found in North America and European countries, where it causes arthritic conditions. <i>Borrelia garinii</i> and <i>Borrelia afzelii</i> occur throughout Europe and Asia. They cause neurological disorders and cutaneous manifestations, respectively. Based on today's knowledge, these spirochetes and their variants occur independently from each other regardless of their tick/host associations. All these genotypes have been isolated from individual ticks as well as from individual patients.
DB: Is there work being done now at the Rocky Mountain Labs on the variance or the subspecies of <i>Borrelia burgdorferi</i> ?
WB: Yes. Dr. Tom Schwan and Dr. Patricia Rosa continue to work on this. They were the ones who first discovered that Borrelia burgdorferi can be divided into subspecies.
DB: And has anyone determined for certain what causes these variances?
WB: No.
DB: So there's just a speculation about the causes?
WB: Yes, as far as the cause is concerned.
DB: Is there any test that has been developed now that can diagnose Lyme disease in a patient?
WB: As yet, there is no specific test for the diagnosis of Lyme disease. A patient's indication includes a history of tick bites and the subsequent development of clinical manifestations including skin, blood, muscle, nervous and joint disorders. For confirmation of the diagnosis, follow up laboratory tests are sometimes used.
DB: And what sort of further or follow up tests can be done to determine that?
WB: Lyme disease can be confirmed in the laboratory by isolation of the causative agent from a patient's blood, cerebrospinal fluid or skin tissues maintained in a liquid medium, or by detection of sero-antibodies specific to <i>Borrelia burgdorferi</i> . Although isolation of spirochetes from patients is recommended, the complexity of culturing techniques does not allow routine application. Once cultured, spirochetes can be identified as <i>Borrelia burgdorferi</i> by their reactivity with monoclonal antibodies or by assays detecting specific DNA of the organism. Various immunoassays such as direct and /or indirect immunofluorescence enzyme-linked immunosorbent assays, and Western immunoblot have been developed to determine a patient's antibody responses to <i>Borrelia burgdorferi</i> . Some of these tests, unfortunately, lack specificity and sensitivity, resulting in false positives as well as false negatives. A patient exposed previously to spirochetes invariably will show titers to <i>Borrelia burgdorferi</i> even though there is no clinical illness.
DB: Are people working on a test?
WB: Oh yes.
DB: You indicated that for some years before your discovery, Lyme disease was a health problem, that people were suffering from the symptoms and nobody figured out what caused them. When was this disease first identified in the United States?
WB: The first identification in Lyme, Connecticut, dates back to 1965.
DB: Is Lyme disease known to affect any animal other than human beings?

Is Lyme disease known to affect any animal other than human beings?



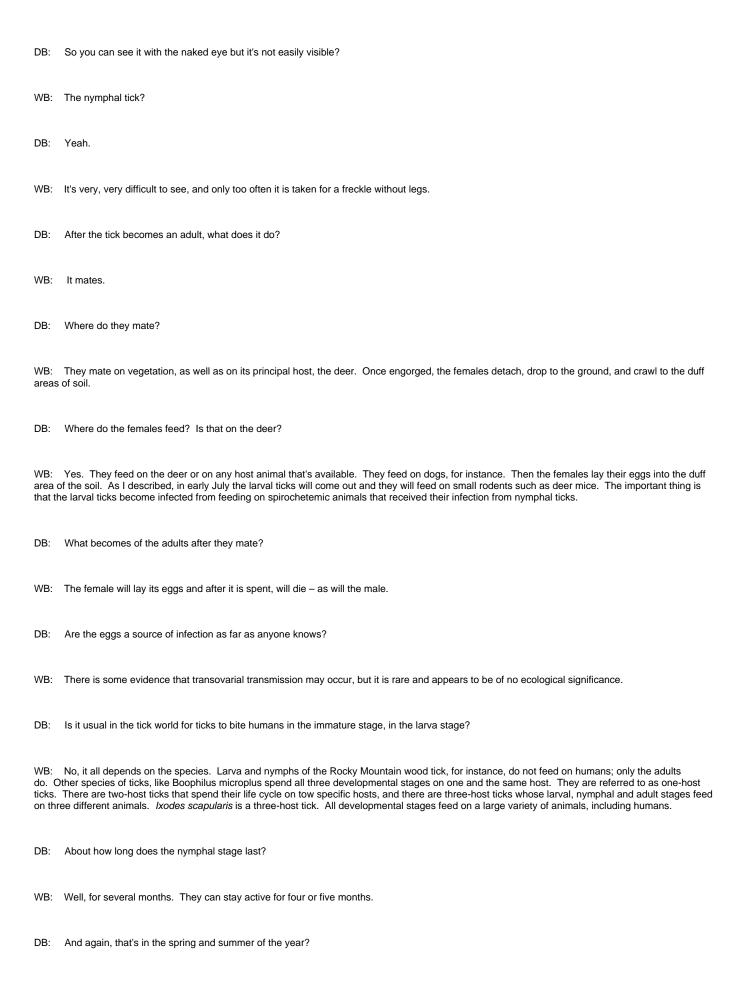


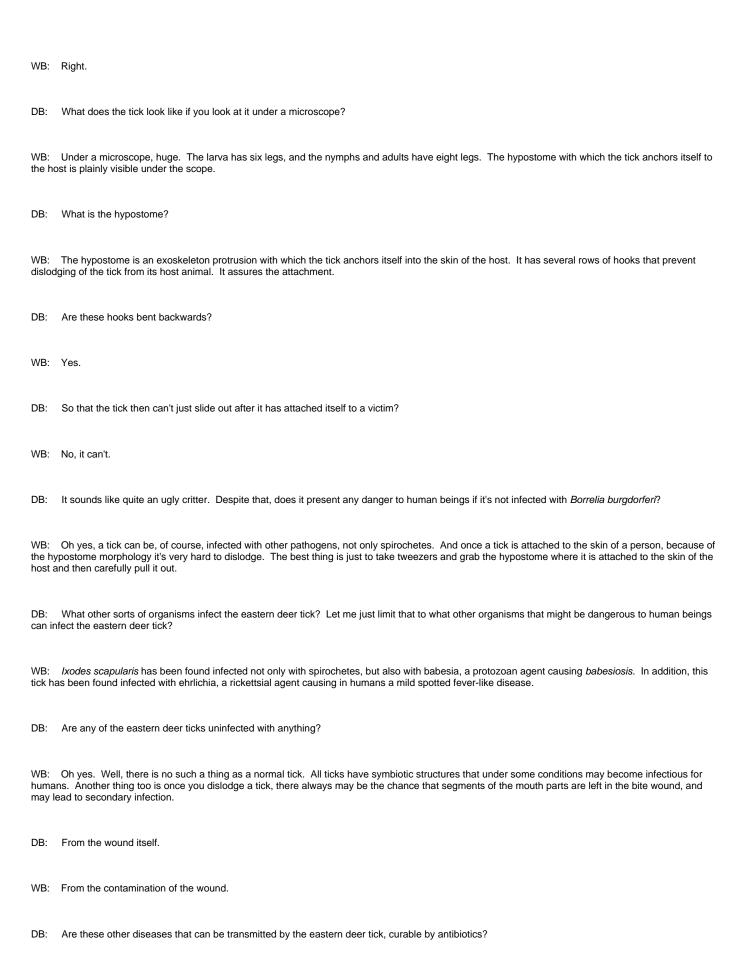
DB:	But you will do that? You will take them and keep them at your home?
WB:	I have a garage that is supposed to house a car. I could store my records there.
DB:	So the materials will be preserved. Is that right?
WB:	They will be preserved.
DB:	When you continued to do work at the Lab after your retirement, did people continue to call you about tick-borne diseases?
WB:	That's correct.
DB:	Were these just lay people or were they colleagues?
	Phone calls have continued, mostly from Lyme disease patients who failed to persuade their physicians to continue with treatment. Even though I s emphasize that I am not a physician – not even able to suggest an aspirin, they insist that discussing their problems with the "expert" helps.
DB:	In addition to that sort of help and support, did you examine ticks that people suspected may have infected them?
WB:	Correct. I'm still doing that many years after retirement.
DB:	And do you expect to continue to do that?
WB:	No, right now I have no place to do the lab work or to handle ticks that may be infected.
DB: would	And in fact nobody wants to be around you while you're doing that. In the event that after this renovation is over you have space at the Lab again, you continue to dissect ticks at the request of people?
WB:	If necessary I would.
DB:	And by "necessary," do you mean if somebody asked you to do it?
WB:	If somebody asked, I'd be very happy to do that.
DB:	Because you've done it all your professional life?
WB:	It's part of the service.
DB:	Speaking of that, were you ever paid for examining ticks at the request of either somebody from the lay public or your colleagues?
WB:	No.

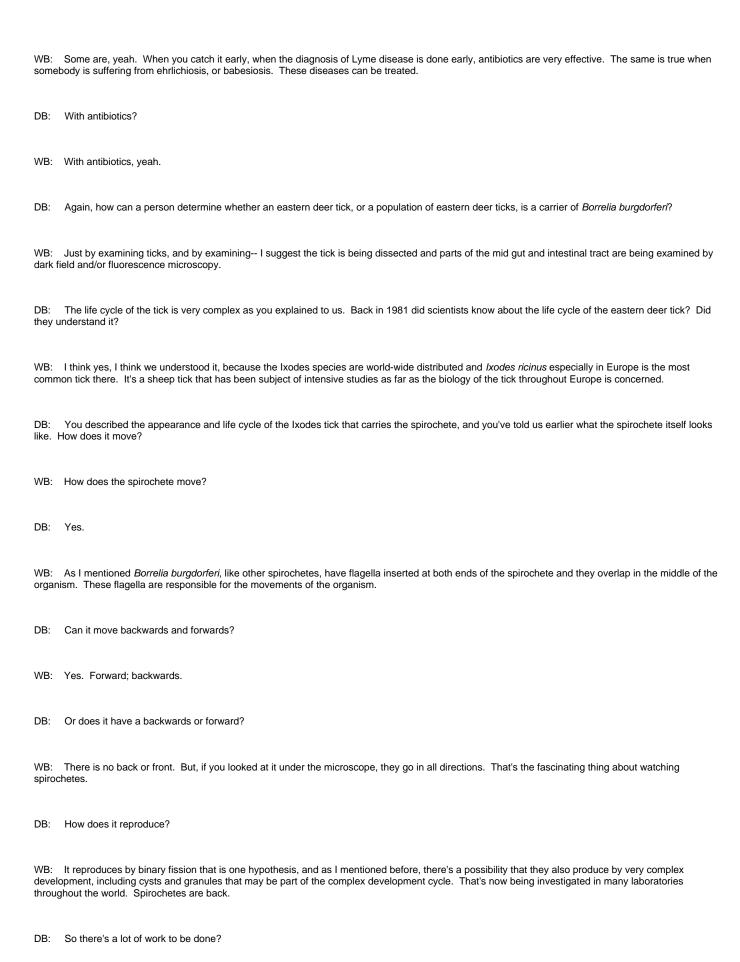
DB: Again, after your retirement did other scientists continue to contact you or seek to collaborate with you? WB: Yeah. I was very active meeting with Dr. Schwan and others who are doing very similar research as I did. We periodically get together and discuss progress, objectives and so on. DB: Dr. Schwan I believe is one of the doctors at the Rocky Mountain Labs that you mentioned had done work or was still doing work on the different areas. He is doing work on the relationship between spirochetes, the host animals, and the ticks. DB: After you retired, do you have any idea or guess about how much of your time was devoted to scientific endeavors? WB: That's hard to say. Did you say, "afterwards"? DB. After you retired. WB: Okay, initially let's say about 50 percent. That went down after five, six, seven years, to maybe 30, 35 percent. And it's now down to very, very little. By scientific endeavors I take it that you include more than just dissecting ticks. You continue to do other things since retirement. Is that true? Such as lectures and write. WB: I have been lecturing every year during the Acarology Summer Program at Ohio State University and as a board member of the Lyme Borreliosis Foundation. I have been very active pursuing papers at its workshops and conferences on Lyme borreliosis and other tick-borne ailments. I also by invitation have attended - and served as keynote speaker - several national and international conferences. Writing papers and keeping up with correspondence also plays an important part of my retirement. DB: And even though you say that your scientific work has dwindled considerably, when was your last publication? WB: My last publication was I think in January of this year in one of the European journals. I was invited to submit a manuscript of my presentation I gave at the International Conference in Munich last year, and this was published in the European journal. DB: So even when you talk about your work being less, you're still quite active. Is that true? WB: Yeah, I'm still quite active. I'm still following the scientific achievement in the literature and there is so much literature it's almost impossible to do that, but being retired I can take some time out for this. DB: I imagine one reason that your scientific work has slowed down somewhat is because you don't have space to do it. Is there any other reason that your scientific efforts have dwindled recently? WB: Yeah, because I'm not an expert in the molecular and genetic biology. DB: Going back to your pre-retirement days, right after your 1981 discovery, what was your main scientific interest or pursuit right after that discovery of the spirochete?

WB: The main interest was to follow up on the development of the spirochete, especially on the hypothesis that it's not only a transverse division as far as the multiplication of the spirochete is concerned, but also a highly complex development that involves the formation of cystic material and spore-like formations that are being formed by the spirochete as a defense mechanism against the immune system of the host. These problems we faced during my thesis but we didn't have the techniques and the molecular procedures or electron microscopy to follow this question up. I feel that the spirochetes do have a very complex system that does involve formations that are not recognizable as typical coiled spirochetes but rather as atypical material that may play a part in the infection of humans and other animals.				
DB:	Did this interest focus on spirochetes in general or more on the one spirochete, Borrelia burgdorferi?			
don't d	That is on the spirochete in general. I am absolutely convinced that the development of spirochetes is far more complex than we assume. They only divide by primary fission, but rather by very complex systems that are still not known and may surprise us as far as the etiology of spirochete in al is concerned.			
DB:	I know that you've published a great number of articles. Do you know how many you've actually published, either as the sole author or co-author.			
WB:	The last paper I published was number 225.			
DB:	How many of those deal with tick-borne diseases?			
WB:	Tick-borne disease or related to tick-borne diseases, I would say 215.			
DB:	So the vast majority.			
nevert diseas was lu	Vast majority has been the relationship between vector ticks and their pathogens. Also I did some virus work on mosquitoes another subject, but theless we had one highlight I'm very proud of and that is the isolation of California encephalitis virus from wild animals. California encephalitis is a see of humans known in the '50s, 60s. The virus had been isolated and characterized but nobody knew where the mosquitoes picked up the virus. I ucky to demonstrate that the snowshoe hare in the Rocky Mountain region are the sole sources of infection, and still even today a lot of work is being on California encephalitis virus.			
DB:	Did you learn this from studying hares locally?			
WB:	Yes. The hare from which we isolated this virus was trapped within a few miles of the Rocky Mountain Laboratory.			
DB:	Where did you find the hare?			
	We found it on an approach to one of our trap lines, sitting in the middle of the road. We assumed that something was wrong with it because it want to get away. So we obtained a blood sample for evaluation in the laboratory.			
DB:	You said it didn't want to get away. Do you mean it just sat there for you?			
WB:	Yeah.			
DB:	But it wasn't in a trap line?			
WB:	It was not in a trap line and we were on the road to our trap line.			

DB:	And when you examined the snowshoe hare's blood, what did you find?		
	It paralyzed hamsters, guinea pigs and suckling mice with manifestations typical of a viral agent. It turned out to be the cause of California halitis – a mosquito-borne disease that is detectable so far only in humans.		
DB:	What year were you doing this work?		
WB:	In 1961.		
DB:	And did you publish an article dealing with it?		
WB:	Published in 1961.		
DB: wonde	Dr. Burgdorfer, I'd like to have you talk briefly about the life cycle of the Ixodes tick, the eastern deer tick, that carries the <i>Borrelia burgdorferi</i> and I'm bring, first of all, if you could tell us what time of year a person is most likely to get Lyme disease.		
	Most likely in June and July. These are the months when the nymphal tick of <i>lxodes scapularis</i> is very active. These nymphs had been infected in evious year as larvae on an infected animal.		
DB:	Now when you say they've been infected on an infected animal, do you know what species of animal they become infected on?		
WB:	Most likely on a deer mouse, which occurs throughout the eastern part of this country, and is the most important source for infecting ticks.		
DB:	So the tick becomes infected and then in turn can infect other mammals?		
WB: That's right. The acquisition of <i>Borrelia burgdorferi</i> by <i>Ixodes scapularis</i> is best described as follows: In late July, August and early September, the larval ticks feed on reservoir-competent mice, <i>Peromyscus leucopus</i> , that had been infected by nymphal ticks in late May, June, and early July. They then spend the winter in the duff of the soil, and in the spring of the following year they molt into nymphs. They will feed in late May, June and July; and molt into adults that feed and mate during December and early spring. Each female lays about 2-to-3,000 eggs in a single cluster in May, June, or early July.			
DB:	Is the likelihood of infection from the adult tick less because there are fewer spirochetes in the adult tick?		
	No, there are just as many spirochetes, but humans discover adult ticks faster than a nymphal tick. Adult ticks are considerably larger; one can see and remove them much faster than a nymphal tick.		
DB: tick in	Before the tape ran out, you were explaining why it is that a person is more likely to be infected by a nymphal tick in the summer than by an adult the fall. Why is that?		
WB: nymph	One of the reasons is that the adult tick is considerably larger up to 5 millimeters than the nymphal tick, and is much easier to detect than a n.		
DB:	So the size of the nymph is about the size of a freckle or something like that?		
WB:	Yeah, about 2 millimeters long.		



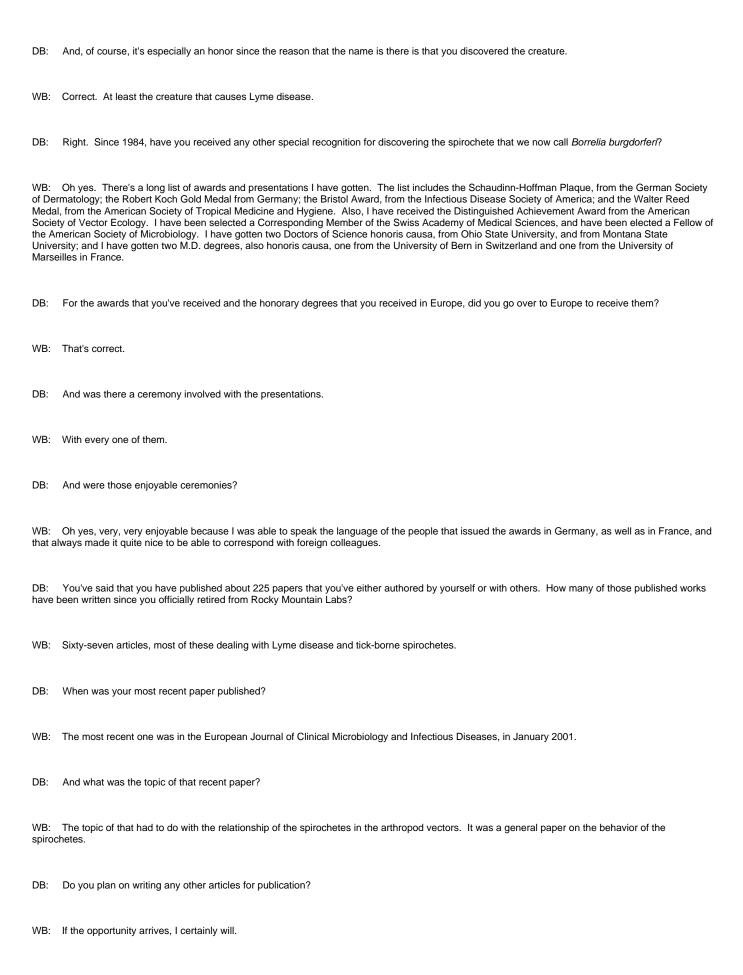




WB: There's a lot of work to be done. There's a lot of work to be done on the physiology of the spirochete and that very likely will have some bearing on the clinical manifestations caused by these organisms. You've alluded to this previously, but could you set forth how this spirochete, the Borrelia burgdorferi, actually gets from the midgut of an infected tick into the human being, into the victim. It appears that ingestion of blood during a tick's feeding initiates the passage of spirochetes from the midgut through the gut epithelium and via hemolymph, into the various tissues, including salivary glands. DB: After Borrelia burgdorferi enters the human skin, where does it go? That's a very good question. It's assumed that they get rapidly into the bloodstream and are carried throughout the system of the host animal, invading the various tissues including the central nervous system. DB: And again, in order to start this process, the tick first has to ingest its victim's blood. Is that true? WB: That is true. DB. And how long does that take usually? Studies done so far suggest that it takes about two days of attachment and feeding before spirochetes are being transmitted to a host animal. This is referred to as the "safety period," during which a person could remove a tick without becoming infected. I personally don't subscribe to this theory, because there are about 5 to 10 percent of infected ticks that have a generalized infection, including salivary glands and saliva at the time of attachment. In such cases, transmission of spirochetes would and does occur immediately at time of attachment. DB: So the longer process is only the case for ticks that carry spirochete only in the midgut. WB: Correct. And, of course, it was in the midgut that you found your spirochete the first time. WB: Correct. DB: As far as you know, is there a relationship between the location of the spirochete in the human victim and the clinical manifestations of Lyme disease? WB: Well, we know that spirochetes are surrounding the erythema migrans lesion and we know that the spirochete can be isolated from the blood and even from the cerebral spinal fluid of a patient. DR: Dr. Burgdorfer, have you yourself seen Borrelia burgdorferi in any locations in the tick other than in the midgut? WB: Yes. We have followed the development of Borrelia burgdorferi in individual ticks and especially the passage of the organism through the gut wall into the body cavity. We also have found them in salivary gland tissues and especially in the ovarian tissues. There they can affect the egg to the point that it will die. So we have seen them throughout the tissues throughout the tick, as we also find in the case with relapsing fever Borrelia.

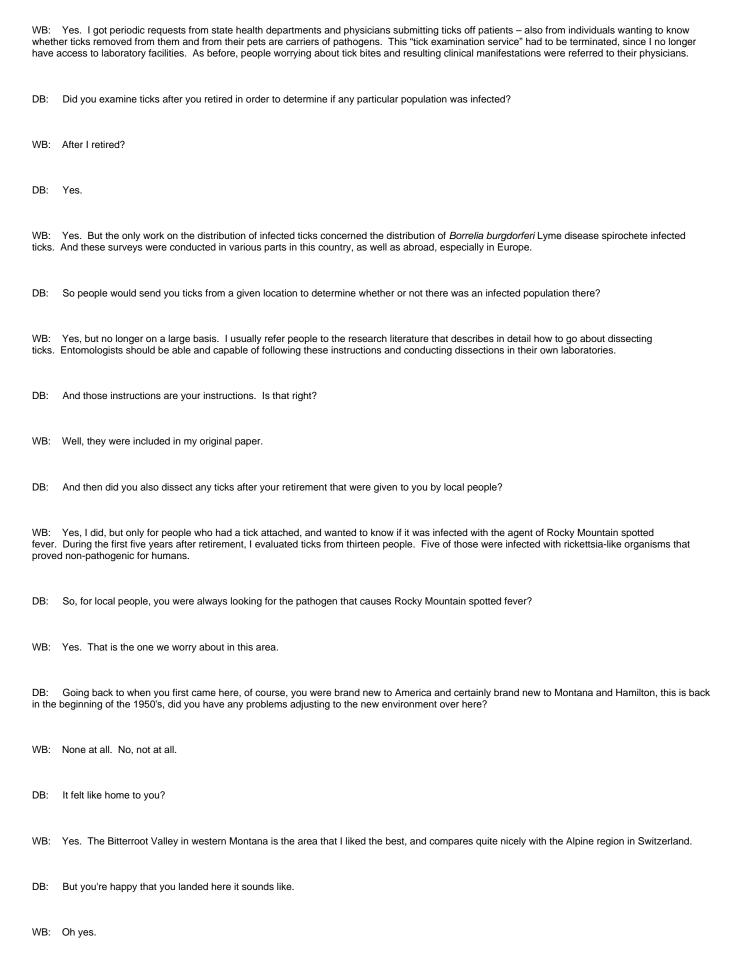
DB:	When you're saying "we've seen that", you yourself have seen that. Is that right?					
WB:	Yeah.					
DB:	And have you yourself done any work to determine how the spirochete is transferred from the tick into its victim?					
specie	Oh yes. As far as the Lyme disease spirochete is concerned, it's via saliva, saliva being injected during the feeding process. There are other tick es, like <i>Ornithodoros moubata</i> , where a fluid referred to as "coxal fluid" is being ejected into the bite wounds or is diffusing through the skin of a host, this fluid is infected with spirochetes, the spirochetes are capable of either to enter into the bite wound or diffusing through the skin and producing an on.					
DB:	And the coxal fluid is something other than saliva?					
WB: gland	Yeah. The coxal fluid occurs in certain, not all, soft ticks like <i>Omithodoros moubata</i> . It originates from a gland which is referred to as the coxal that filters the fluid taken up during the tick's feeding. Fluid of no biological value is being ejected, giving the tick the ability to ingest more blood.					
DB:	But the Ixodes tick does not have any this coxal fluid. Is that right?					
WB:	That's correct.					
DB: helps	So it sounds like you've done work not only to determine the manner of transfer of <i>Borrelia burgdorferi</i> into a victim, but you've done research that explain the manner of transfer of other disease-causing organisms from other ticks. Is that right?					
WB:	Vac					
	Dr. Burgdorfer, you said that you've worked on preventing tick-caused diseases by working on educating the public, and you talked about some of lucational efforts that you've undertaken. Could you talk in a little more detail about some of the educational tools that you've worked on to try to the the public about ticks and tick-borne diseases.					
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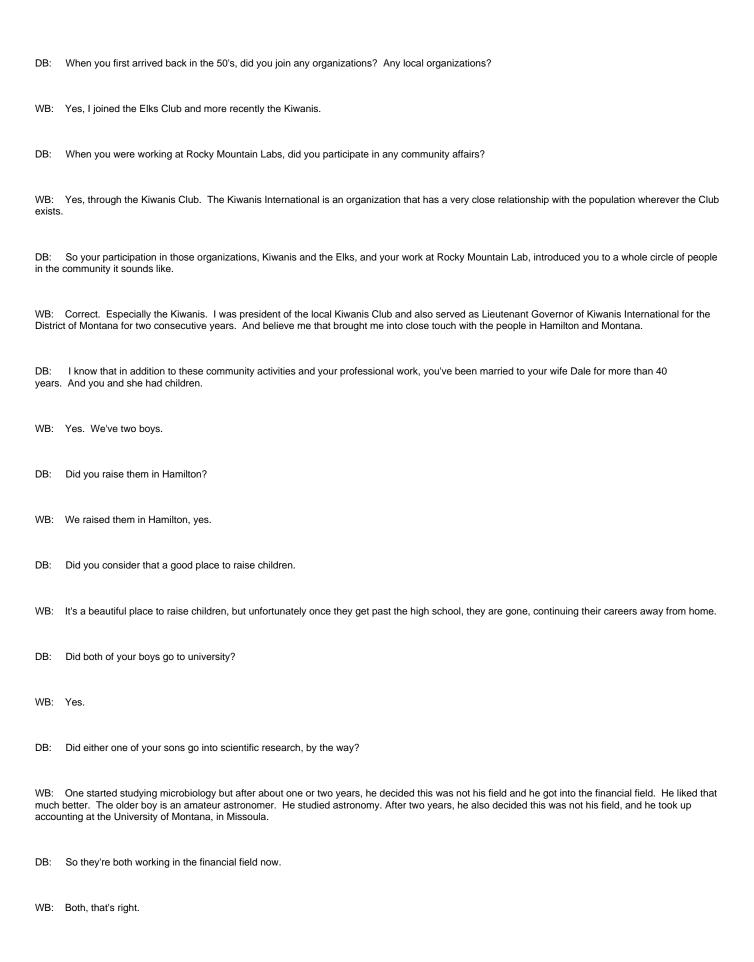
WB: It's an honor to have my name attached to the pathogen I studied throughout most of my career.



DB:	Are many of your most recent articles written in response to requests from other people?
	That's true. Because few of today's molecular biologists are aware of the circumstances that led to the discovery of spirochetes, I have been asked rious occasions to present historical reviews on research that led to the current knowledge of these arthropod-borne microorganisms.
DB:	And that's because you've been involved in this field of study for so long and have such a sense of history of the research. Is that right?
	That is true. And also because I collected most of the articles on certain subjects. I kept up with the reviews and I am able to pull out the original and compare their findings with what is being presented today.
DB:	Again, you're continuing to keep track of the research that is done in this field. Is that right?
WB:	As much as I can.
DB: contin	You've already talked about the fact that you have lectured a great deal. Does this lecture activity, or is this lecture activity something that used after you officially retired from Rocky Mountain Labs?
WB:	Yes.
DB:	Is that because you have more time?
	Yes. And also because the scientific articles from other laboratories continue to result in an increased number of publications that shed additional on the subject.
DB: S	So you're saying that you're able to see your work with a different perspective now that additional work has been done?
WB:	Correct. That's work actually throughout the world.
DB: \	What was the most recent lecture that you've given?
	The most recent one was in Munich at the International Conference on Lyme disease and tick-borne diseases. That had to do with the physiology spirochete.
DB:	Did you give that lecture in English or German, or both?
WB:	I gave it in English because the official language in these international conferences is English.
DB:	When you go to these meetings, these professional meetings, are you recognized by the other attendees?
WB:	Yeah, hopefully I am. I don't want to blow my own horn here, but so far, my work has been recognized world-wide.
DB:	So you're keeping in contact with people who know your work and know you.

WB: That's correct.	
DB: Have all of the lectures that you've given since your retirement been related to Lyme disease, or have you given lectures on other tick-borne diseases?	
WB: I've given lectures on other tick-borne diseases, but the majority of the recent lectures, talks and discussions have been on Lyme disease and related spirochetoses.	
DB: Have more of these lectures been in the United States, or have more been in Europe?	
WB: More have been in the United States. As a member of the Lyme Borreliosis Foundation, I have been asked to give lectures at every congress or every workshop supported by it.	
DB: So that means that you're going to continue to get requests to give lectures. Is that right?	
WB: Correct.	
DB: And do you plan on continuing to do that?	
WB: Yeah, as long as I'm healthy and as long as I am able to keep up with the literature and with the findings in this field, I'll be glad to do so.	
DB: It sounds like you maintain pretty close contact with scientists who are working on tick-borne diseases both at Rocky Mountain Lab and elsewhere. Is that true?	
WB: Yes.	
DB: And you've already mentioned some of the scientific professional organizations that you're a member of. How many scientific professional organizations do you belong to?	
WB: Actually, right now I have a membership in four societies. I used to be a member of six additional societies, but no longer belong to them.	
DB: What four societies are you a member of?	
WB: The American Society for Rickettsiology, the Lyme Borreliosis Foundation, the Swiss Academy of Medical Sciences, and the American Society of Microbiology.	
DB: Two of those groups are involved with the two organisms that you've done most of your work on: That is the rickettsiae and the spirochetes.	
WB: Correct.	
DB: You already indicated that even after you retired, you continued to dissect and examine ticks. Did you examine these ticks at somebody's reques	t?





DB:	Hopefully that will be helpful to you. Do either of the boys live in Montana? Or the young men, they're not boys any more.
WB:	Yes. Bill the older one has an accounting firm in Dillon, Montana.
DB:	And where does Carl live?
WB:	Carl lives in Eugene, Oregon, and he's associated with U. S. Bancorp.
DB: work a	You've already told us that your wife was working as a secretary and technician at the Rocky Mountain Lab when you met her. Did she continue to after your marriage?
WB:	She continued to work until the first boy came along. That was about two years.
	You've already told us that you and your wife Dale lived in a house in downtown Hamilton after you got married. Did you continue to live there after ildren came?
WB:	Yes, we did.
DB:	And is that the same house you're living in today?
WB:	It's the same house we live in today.
DB:	And again, that's just a number of blocks from the Rocky Mountain Labs. Is that right?
WB:	Yes, it's only two and a half blocks.
DB:	When you were working at Rocky Mountain Labs, I take it that made it easier to go back and forth to the laboratory to do work.
WB:	Fortunately and unfortunately.
DB:	You told us that you worked past midnight sometimes.
WB:	I spent a lot of time at the Laboratory.
DB:	So it was almost too easy for you to spend time at your lab. Is that right?
WB:	That's correct.
DB:	When you were working full time at the Labs, were you able to spend much time with your family?

WB: I think I spent considerable time with the family, although maybe not as much as I should have because it was so easy to go back to continue or finish the work that you started during the day, instead of spending time with the children. But in spite of that, I spent a lot of time with the children playing soccer and going fishing, teaching them outdoors and so on. We had a good time together.
DB: Living in Hamilton, of course, made it easy to do these outdoor activities. Is that right?
WB: That's correct. Those kids knew more about fishing spots here in the Bitterroot River than I did, and whenever we went together they caught just as many fish as I did.
DB: Do they come back here to fish and to enjoy the environment here?
WB: Maybe not to fish, but certainly enjoy coming back and enjoy to play golf, so we still have a good time together. It has gotten more competitive, however, and Dad is no longer in first place.
DB: Going back to the work schedule at the Lab where you said you went back to work and sometimes worked past midnight, do you think that this sort of dedication and focus that you spent on your work at Rocky Mountain Labs is required in order for a scientist to become and remain prominent in his or her field?
WB: Well, it certainly is not required, but it will help to keep up with what is going on in other laboratories, and is responsible for the accomplishments for writing papers and all that. Without this dedication probably I never would have reached that point where I am today.
DB: And again you've written at least 225 papers, written or written with others, at least 225 papers that have been published. And that just takes a lot of time. Is that right?
WB: Certainly. Especially if you have to learn first how to write papers.
DB: And you talked about that, in 1951 having to learn almost from scratch how to write a paper. I take it you got that down though since you have written quite a few. You figured out how to write papers.
WB: Yes.
DB: And in fact you've helped others write papers since then.
WB: Yes.
DB: Since you retired, have you continued to engage in community activities in Hamilton?
WB: Yes, I have as a Kiwanian, at the Kiwanis Club. I've been very active.
DB: Back to when you were talking about participating in soccer with your children, were you actively involved in soccer in Hamilton when your children were growing up?
WB: Yes, I was. I was one of those who introduced soccer to the Bitterroot Valley.
DB: And where did you become introduced to soccer?

	In can play. It is a popular sport in Europe, especially in Switzenand. I always United States. The past few years have shown that I was right. When we started this a very complex league that involves more than 600 boys and girls.
DB: Are you involved in the soccer program in Hamilton anymore?	
WB: No more. I used to coach, referee and even broadcast games of	on local T.V.
DB: You know children who are actively involved in it?	
WB: Oh yes. Once in a while somebody comes up and says, "Hi, W	illy, do you remember me? I used to be your striker or I used to be your goalie."
	done in your field, and then you do the Kiwanis work. I know just from passing by flower garden. What is the majority of your time and energy spent on these days?
WB: Right now, in taking care of my wife. She unfortunately had a fastroke, and is now severely handicapped.	all two years ago and had to have brain surgery. During surgery she suffered a
DB: So that is the prime interest and activity that you're engaged in	at this time?
WB: That's correct.	
DB: Dr. Burgdorfer, looking back over things, it sounds like you're had glad that you moved here?	appy that you moved to Hamilton more than 50 years ago. Can you say that you are
WB: Very, very happy. I was fortunate that everything sooner or late	er fell into place and so I have all the reasons, every reason, to be happy.
DB: And then specifically, how do you feel about your career at Roc	ky Mountain Laboratory looking back over it?
WB: Looking over my career, I can only say it was a good one, a ver only in this country but also in Europe, agree with me.	y productive one. It was an exciting career, and I am happy that my colleagues, not
DB: And you said it was a good career. From what you've told us yo	ou're still working in your field, and I take it, it still is a good career. Is that right?
WB: Yes. I still have a lot of correspondence on the various subjects spirochete.	s I worked on, more especially on the late subject and that is Lyme disease and its
DB: Thank you very much.	